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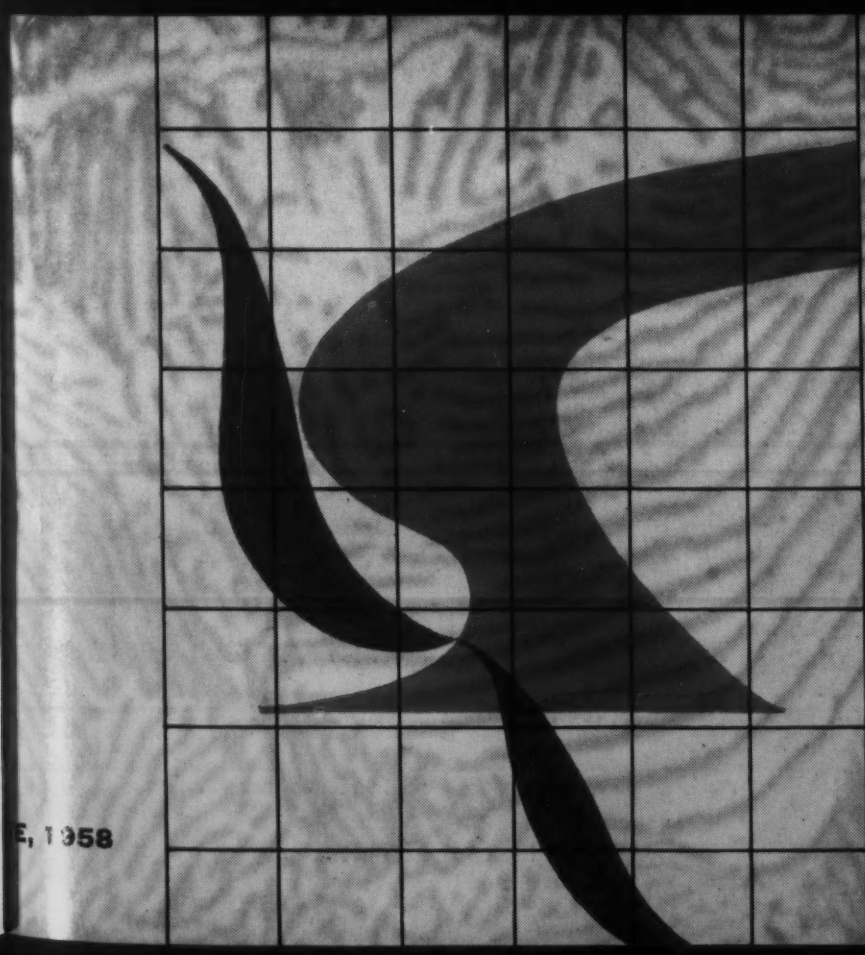
Materials in Design Engineering

FORMERLY
MATERIALS
& METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES



DESIGNING WITH HEAT TREATED STEELS
MANUAL NO. 149

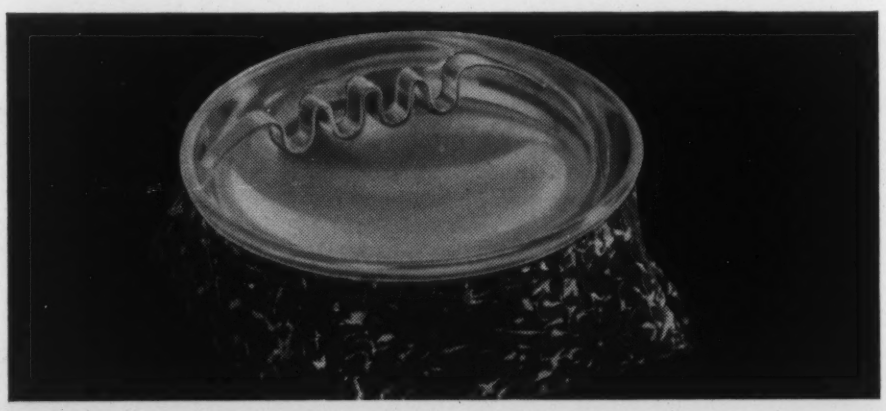
ALSO: SELECTING BEARING METALS
PLASTICS TO 25,000 F?
COMPLETE CONTENTS—PAGE 1

E, 1958

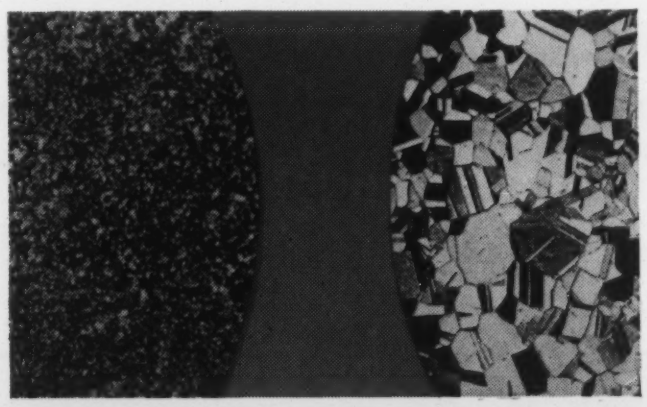
NEW BRASS SPEEDS FINISHING operations for Park Sherman Co.—Formbrite, Superfine-Grain Drawing Brass by Anaconda, reduces polishing time—cuts cost up to 50%—gives clean, easy formability.

TO THE PARK SHERMAN CO., Springfield, Ill., finishing operations are important in giving its line of fine brassware sales appeal—are also weighty cost factors. Switching from ordinary drawing brass to Formbrite, Park Sherman boosted production on the tray of this "Merry-Go-Round" Bar—25% in the cutting operation—42% in finish buff.

THE COVER of this Park Sherman Silent Butler is now made of Formbrite, Anaconda's Superfine-Grain Drawing Brass. Polishing operations in preparation for chromium plating are 50% faster than with ordinary drawing brass.



PRODUCTION INCREASED 47% in finishing operations on this Park Sherman Sta-Put ashtray after the shift to Formbrite. Products shown are only three of many Park Sherman products now made of Formbrite.



THE SECRET of Formbrite's superior polishing characteristics is its superfine-grain. Micrographs (75X): left, Formbrite; right, ordinary drawing brass.

Wherever finishing is an important cost factor in formed or drawn products, Formbrite in sheet and strip is designed to save you money. In brass wire alloys for cold-heading and upsetting, it gives a stronger, springier, more abrasion-resistant product. For more detailed information, write for Publication B-39. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5848

FORMBRITE®

SUPERFINE-GRAIN DRAWING BRASS

a product of

ANACONDA®

Made by The American Brass Company

For more information, turn to Reader Service card, circle No. 435

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Materials
in Design Engineering. *formerly Materials & Methods*

Selection & use of metals, nonmetallics, forms, finishes

JUNE 1958
VOL. 47, NO. 6

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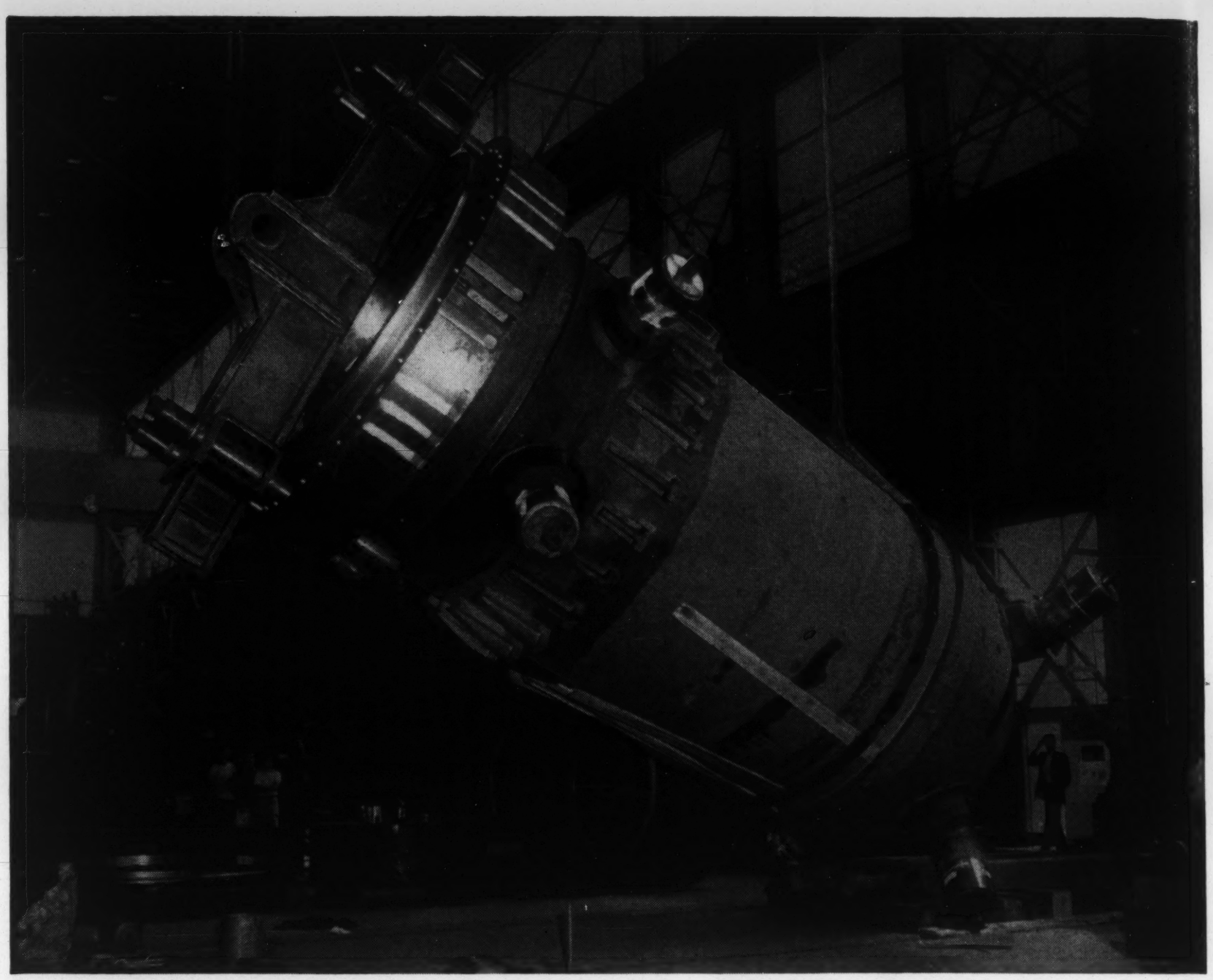
COVER BY HARRY & MARION ZELENKO



Bringing home the atom. Electricity will soon flow from the first full-scale nuclear power plant in America. This 235-ton reactor vessel was designed and built with alloy steels and nickel alloys by Combustion Engineering, Inc. It will supply power for the 60,000 kilowatt Shippingport plant designed by Westinghouse Electric Corporation.

In Shippingport atomic reactor...

Inconel "X" will keep "hungry water" on a starvation diet

"Hungry water" is the apt name for high-purity coolant that whirls through the super-hot core of a nuclear reactor.

It tries to feed on anything it touches!

Its immoderate appetite explains why the reactor for America's first full-scale commercial nuclear power plant had to be designed and constructed as it was—*with core mount springs made of Inconel "X"* age-hardenable nickel-chromium-iron alloy.*

Other spring materials would relax long before operating temperatures hit their peak above 500°F. Or they might fail completely from what is called "stress-corrosion cracking", or embrittlement. In either event, it would be impossible to make repairs because of radioactivity.

It was this consideration that practically dictated the choice of Inconel "X" alloy. An exceptionally tough spring material, Inconel "X" alloy stands up to heat . . . corrosion . . . stress. In a lifetime of use, it's not expected to give "hungry water" a morsel of encouragement!

Have you a metal problem? One involving corrosion, high or low temperatures, abrasion, fatigue? Some helpful answers are in our "Standard Alloys for Special Problems". Ask for a copy. If your problem involves springs, as this one did, ask us for *Technical Bulletin T-35.* Contains complete design information on Inco Nickel alloys for helical springs; it'll prove a valuable addition to your engineering reference files.

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INCO NICKEL ALLOYS

NICKEL ALLOYS PERFORM BETTER LONGER

For more information, turn to Reader Service card, circle No. 404

What's new IN MATERIALS

...AT A GLANCE

HIGH DENSITY POLYETHYLENE WITH BETTER IMPACT STRENGTH and better low temperature toughness than high density polyethylenes produced by the Ziegler process results from a low pressure process using a new catalyst system that produces a high molecular weight, narrow molecular weight distribution, and a high degree of linearity. The resin is still in the development stage.

ANOTHER HIGH DENSITY RESIN WITH IMPROVED LOAD-BEARING PROPERTIES and excellent resistance to environmental and thermal stress cracking is also in the development stage. A filament made of the new material is said to hold a load of 20,000 psi for 2000 hr without breaking. The producer says the resin is easier to process than other high density polyethylenes with similar stress cracking characteristics.

HIGH PURITY COLUMBIUM, MOLYBDENUM, TANTALUM and other special metals can be obtained by a new melting and casting process at substantially lower costs than presently used vacuum arc melting processes. The melting technique uses electron bombardment in a high vacuum to melt materials. It is said to have several important advantages over vacuum melting: 1) it can be stopped and started at any time; 2) it can melt materials in any form; and 3) it can operate with less power than vacuum arc melting.

INCREASED USE OF ACRYLIC FABRICS in outdoor furniture, radio covers and other products is anticipated with the development of a process that heat-forms the fabrics into a variety of shapes. Forming is done by forcing a cold die into a stretched piece of fabric and heating the die to 320 F until the fabric takes its shape; the shaped fabric is then cooled and trimmed. The producer says the shaped acrylic fabric retains its form until reheated to 320 F. (More details next month.)

SEMI-TRANSPARENT CERAMIC PARTS AS THIN AS 0.005 IN. are now available in production lot quantities; the producer says the thinnest part previously available was one measuring 0.009 in. in thickness. The ultra-thin parts are said to have good high temperature and

electrical properties, and good dimensional stability. Fuses, relays, transistor platforms and insulators are a few of the uses anticipated.

A GROUP OF CERAMICS WITH GOOD THERMAL SHOCK RESISTANCE is now commercially available. One ceramic has a coefficient of thermal expansion of 0 and can be used continuously at 1800 F, intermittently at 2100 F. The ceramics are lithium-aluminum-silicate materials. (More details next month.)

EXCELLENT HIGH TEMPERATURE INSULATION can be attained by using a heavy bodied, dough-like refractory ceramic coating reinforced with an expanded mild steel section. The steel section is seam welded to the base metal and the coating is then applied by pressure rolling it onto the expanded metal. The coating is said to provide good thermal insulation for aircraft structural members operating at 2000-3000 F. (More details next month.)

TWO NEW HIGH TEMPERATURE ALLOYS for jet, rocket and gas turbine parts are now available in experimental quantities. One alloy, a nickel-chromium-base material, is said to have high strength at temperatures up to 1600 F; the other alloy, an iron-chromium-manganese-base material, is said to have outstanding creep-rupture properties at temperatures up to 1500 F.

A FLEXIBLE BEARING WITH GOOD WEAR RESISTANCE at high temperatures is available in the form of a long composite fabric tube encased in a short silicone rubber tube. The fabric tube consists of an inner layer of multi-filament tetrafluoroethylene and an outer layer of spun Dacron yarn which has been impregnated with a silicone rubber. The bearing is said to be well suited for rotating shafts and high temperature aircraft applications. (More details in a forthcoming issue.)

LOWER COST WOOD PRODUCTS than presently available will probably come out of the development of a new machine process that imparts a smooth, glossy, mar and water resistant finish to any type of wood in one operation. The process uses pressure and friction to create heat which melts lignin, a natural resin in the wood; the lignin is blended with a special synthetic resin to form the finish. The producer says only one coat of paint, stain or varnish is required to cover the wood.

Turn to page 141 for more "What's New in Materials"

MATERIALS BRIEFS

Alloy Wood Cutter

Grooves for the stick of lead in wooden pencils—a billion or so a year—are cut with special tools made in many cases of a tungsten-molybdenum-vanadium alloy.

Polyester Eyelash

A false eyelash that keeps its curl in rainy weather, looks like the real thing, and is lightweight is now on the market. The lash, made of vinyl-coated polyester film, is applied with a pressure sensitive adhesive.

Tanks to Magnesium

A 5-in. long bar composed of a special magnesium alloy is said to drastically reduce corrosion and sludge formation in fuel oil storage tanks by attracting acids and varnish to itself rather than to the tank.

Atomic Golf Balls

Golf balls treated with gamma rays give longer driving distances and have tougher covers, according to recent research. The golf balls are not radioactive.

Cool Minnows

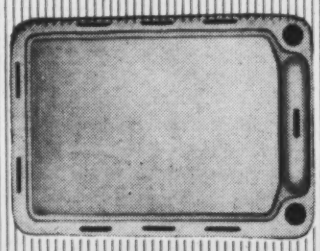
A polyethylene pail is now available to fishermen as a bait box for live minnows. The pail, which floats, is said to keep minnows alive and cool.

Out of This World

Scientists are learning how metallic and nonmetallic materials behave in outer space by using a newly developed high vacuum test chamber that simulates atmospheric conditions 400 miles above the earth.

ALUMINUM

PERMANENT MOLD CASTINGS



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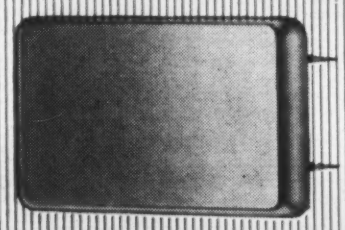


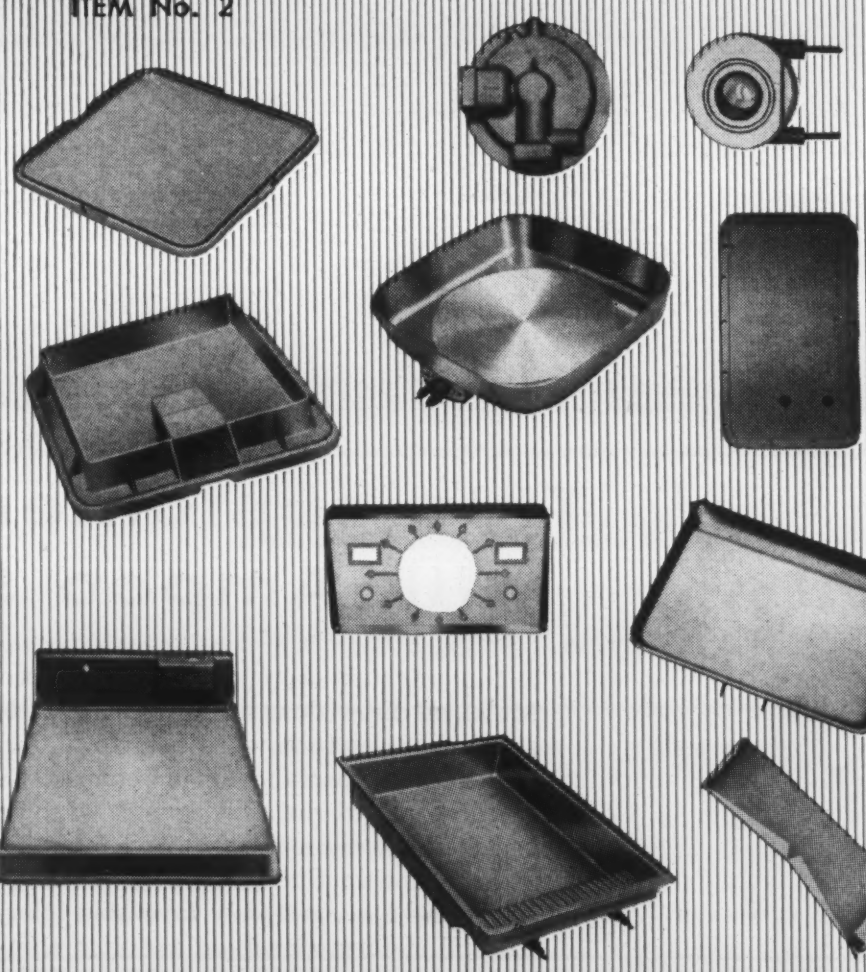
ITEM No. 2

STANDARD AND CUSTOM MADE

Items No. 1 and 2 are standard. Other Griddles for gas and electric ranges are custom made with our exclusive DURAGLAZE or SATIN finishes. They are most popular because they do not discolor easily and cleaning is quick and simple.

Many other styles not shown are available as standard items. Write for full particulars.

MAY WE QUOTE ON YOUR REQUIREMENTS.



Exalco MANUFACTURING CO.

ALUMINUM IN PERMANENT MOLD

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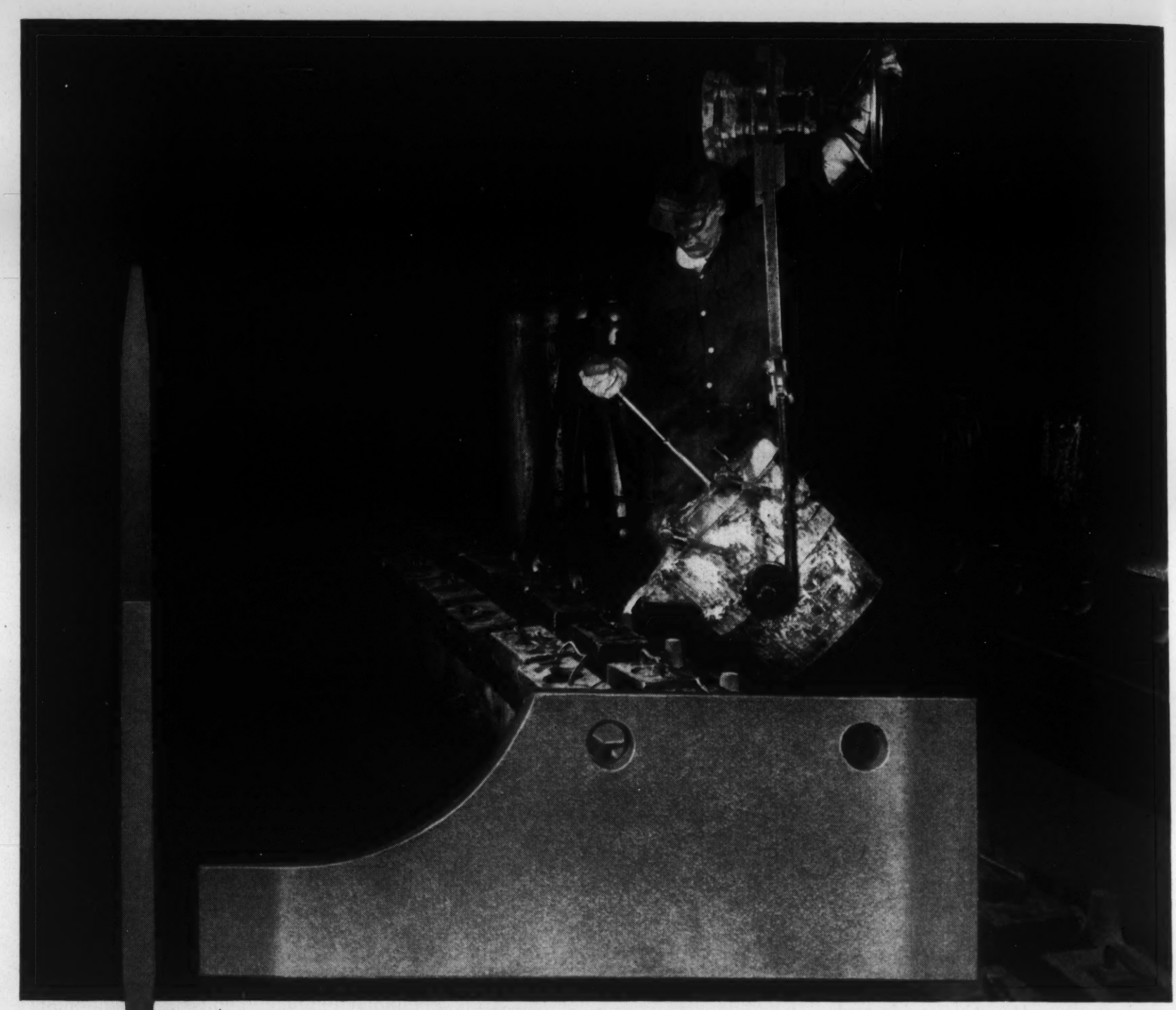
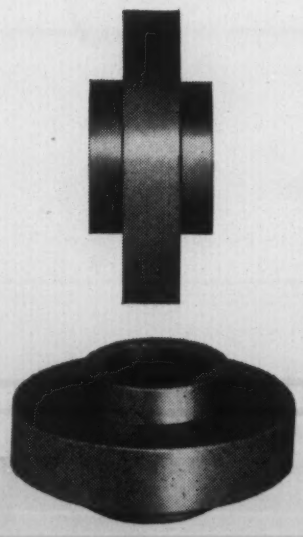


This customer SAVED TWICE with Ampco Shell Moldings



Gear blank shell-cast in Ampcoloy nickel bronze. Surface finish was held to ± .015. Only finishing required was to hob teeth and broach key-way. Savings were considerable.

In the wear strip above, shell-cast of Ampco Metal, all dimensions including end-bevels and hole locations were held to ±.015. The smooth surface finish required no machining. Substantial savings of time and money were realized.

With Ampco Shell Moldings, castings can be held to extremely favorable tolerances. Finishing operations are often eliminated; less metal is wasted. More of the tough outer cast shell is retained, providing longer service life.

Casting detail is excellent — oil grooves, deep pockets, and recesses can be cast in, and coring is close and precise, for complex designs impractical by other methods. High production rates reduce molding costs.

Ampco Shell Moldings are available in an extremely wide range of copper-base alloys. Ask an Ampco field engineer to tell you more about this money-saving production process. And write for Bulletin G36-957. *Ampco Metal, Inc., Dept.* MDE-6, *Milwaukee 46, Wisconsin. (West Coast Plant: Burbank, Calif.—Southwest: Garland [Dallas County], Texas).*

RM-9

AMPCO

ONE-SOURCE SERVICE FROM RAW MATERIAL TO FINISHED PRODUCT

For more information, turn to Reader Service card, circle No. 524

MATERIALS AT WORK

New and interesting applications of engineering materials

Powerful steel centrifuge exerts force of 100 g

Shown above is what is claimed to be one of the most powerful centrifuges built in this country: it is capable of whirling a 2000-lb object at 121 rpm and exerting a force equal to 100 times the pull of gravity.

The huge machine, built entirely of steel, is used by Convair Div., General Dynamics Corp., to test three different environmental conditions likely to be faced by intercontinental ballistics missiles: in addition to subjecting components to extreme acceleration and deceleration, the centrifuge is designed to accommodate vibration mechanisms and to create temperatures ranging from —100 F to 350 F.

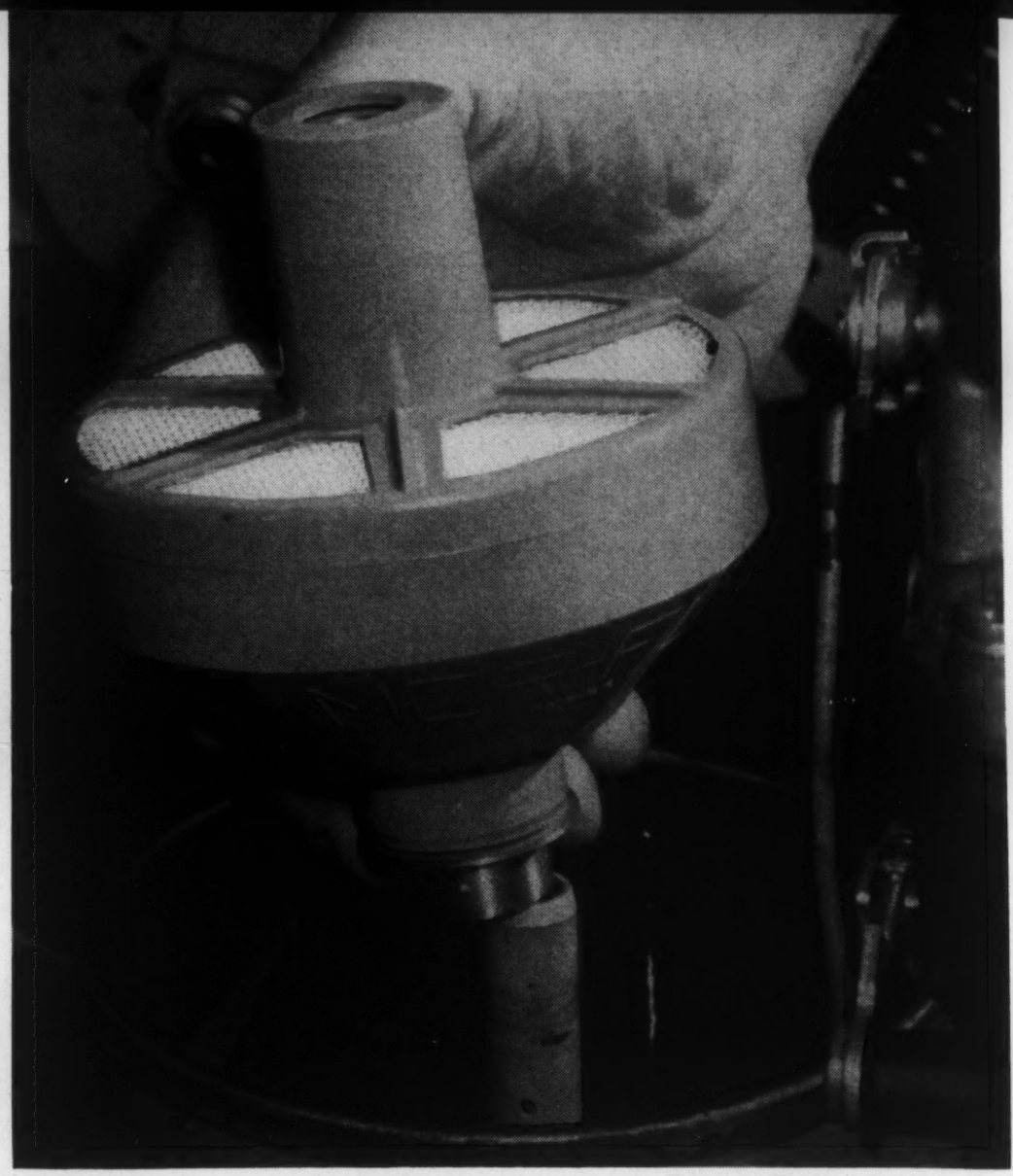
Components to be tested are bolted into the 3-ft-long, 2-ft-dia, sharp-nosed steel test capsule; oversized components are handled by dismantling the test carrier and attaching them directly to the end of the 20-ft boom.

Butyrate oil filter replaces metal unit

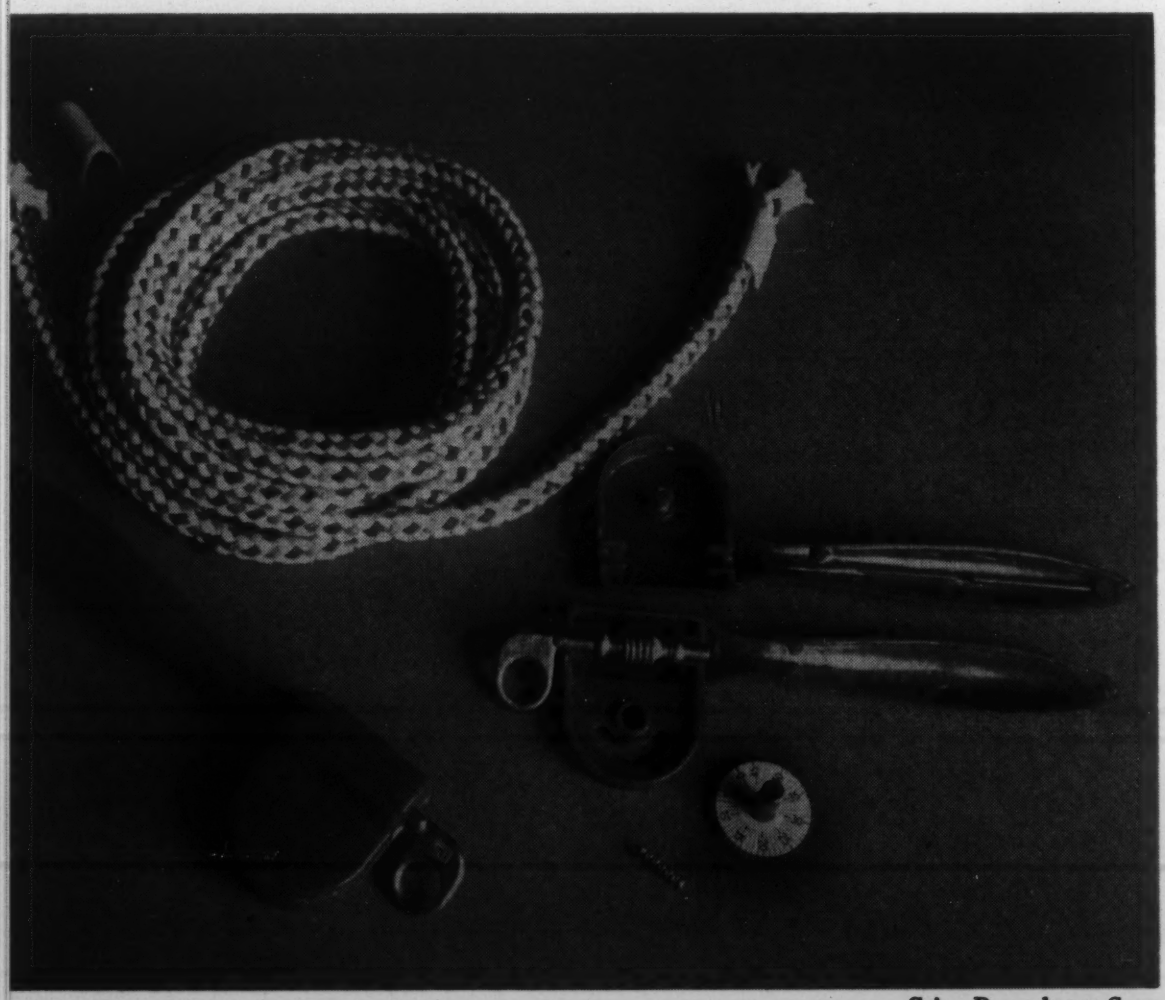
The use of cellulose acetate butyrate has resulted in substantial improvements in the design of a new automotive oil filter cartridge.

According to Acme Plastics Products Co., the filter is more efficient than previous metal units because residual static electricity present in the butyrate provides an added means of retaining fine settlings and preventing their recirculation to the engine. In addition, the plastics unit has multiple filter traps and three settling areas—all in less space than is usually required (see photo).

The new unit is used in conjunction with a steel adapter which enables it to be installed in many models of automobiles, trucks and gas engines.



Eastman Chemical Products, Inc.



Gries Reproducer Corp.

Zinc and polystyrene in novel toy

Injection molded polystyrene and die cast zinc are successfully combined in a unique children's toy—a jump rope with a built-in counter.

As shown in the accompanying photo, the mechanism is quite simple, involving only a zinc worm and gear assembly and high-impact polystyrene handles. The worm and gear are enclosed in one of the polystyrene handles, and a segment of the gear (which acts as the counter) is visible through a crescent-shaped window in the handle.

According to Pressman Toy Corp., die cast zinc is used for the counting mechanism because: 1) it is the most inexpensive way to produce gear and post in one operation; 2) parts are smooth and shiny and thus not dangerous; and 3) extremely close tolerances can be achieved.

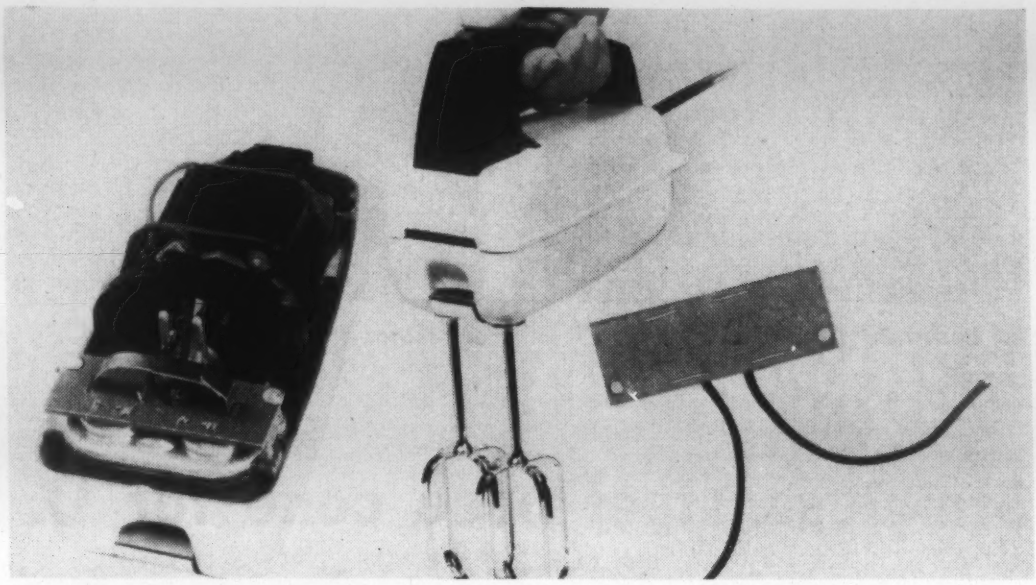
High-impact polystyrene was selected for the handles because it is extremely durable and easy to mold.

Moisture resistant fibre has good properties for . . .

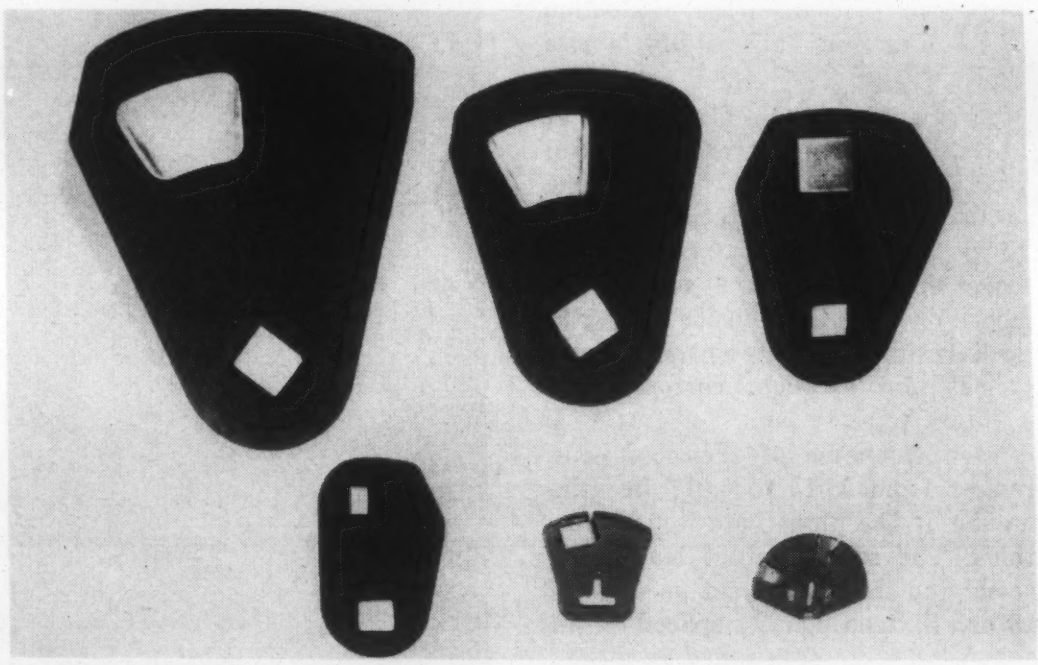
A relatively new electrical insulating material which combines the electrical properties of vulcanized fibre with the moisture resistance of plastics laminates, is presently being used in: arc deflector spacers, transformer and motor coil lead bushings, circuit breaker and transformer barriers, knife switch guides, transformer coil separators, instrument and contact panels, baseboard receptacles and many other devices.

Called Vulcoid and manufactured by Continental Diamond Fibre Co., the material is described as an "intermediate insulation material ideal for high volume electrical applications." It is said to perform as well as glass-epoxy or Teflon laminates, yet cost much less.

The material is made by immersing wet indurated vulcanized fibre in an aqueous solution of aniline formaldehyde. According to the producer, Vulcoid is easily sawed, machined and punched, and can be postformed into permanent shapes without sacrificing strength or dimensional stability.

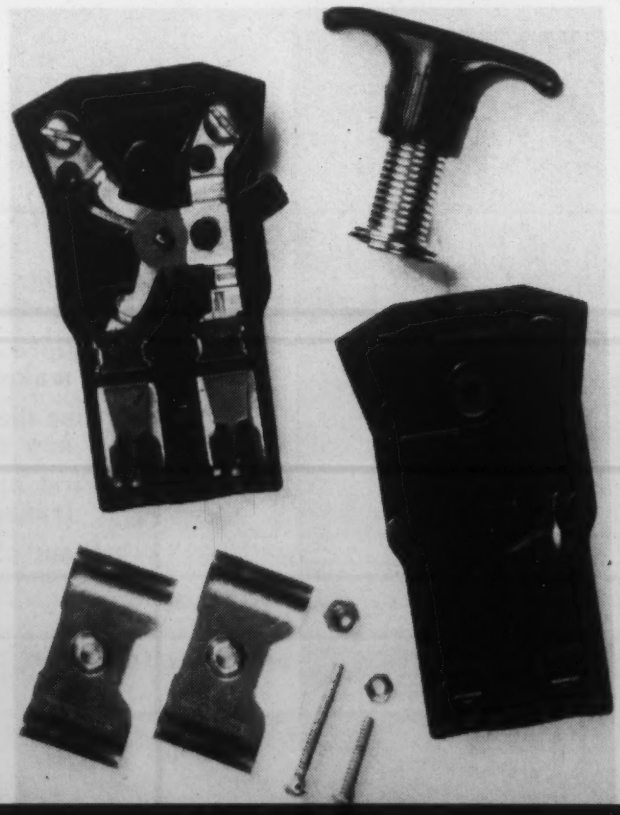


Switch mounting plates *in portable food mixer.*

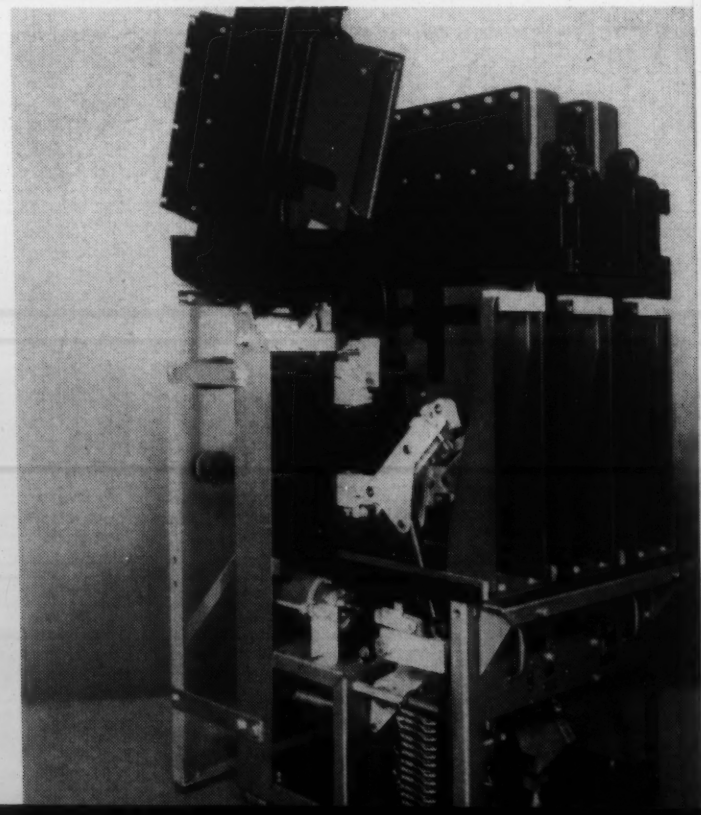


Rotor elements *for various switches.*

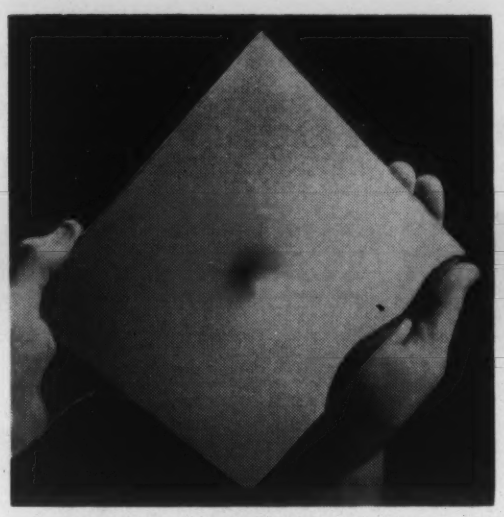
Pivots of switching device *in flat iron or toaster plug.*



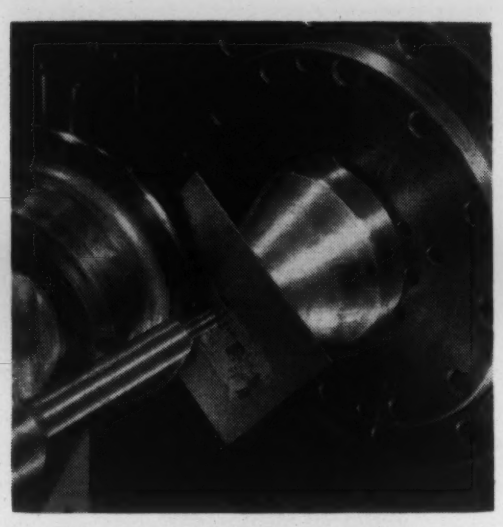
Jump gap runner encasements *in horizontal drawout circuit breakers.*



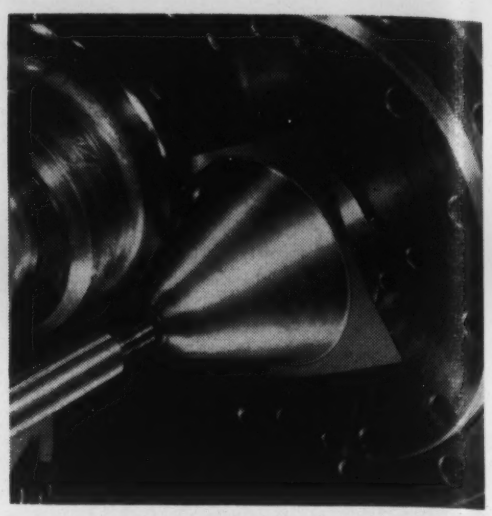
MATERIALS AT WORK



1. Dimpled blank is . . .



2. Placed on machine and . . .



3. revolved against conical mandrel, trimmed and annealed.

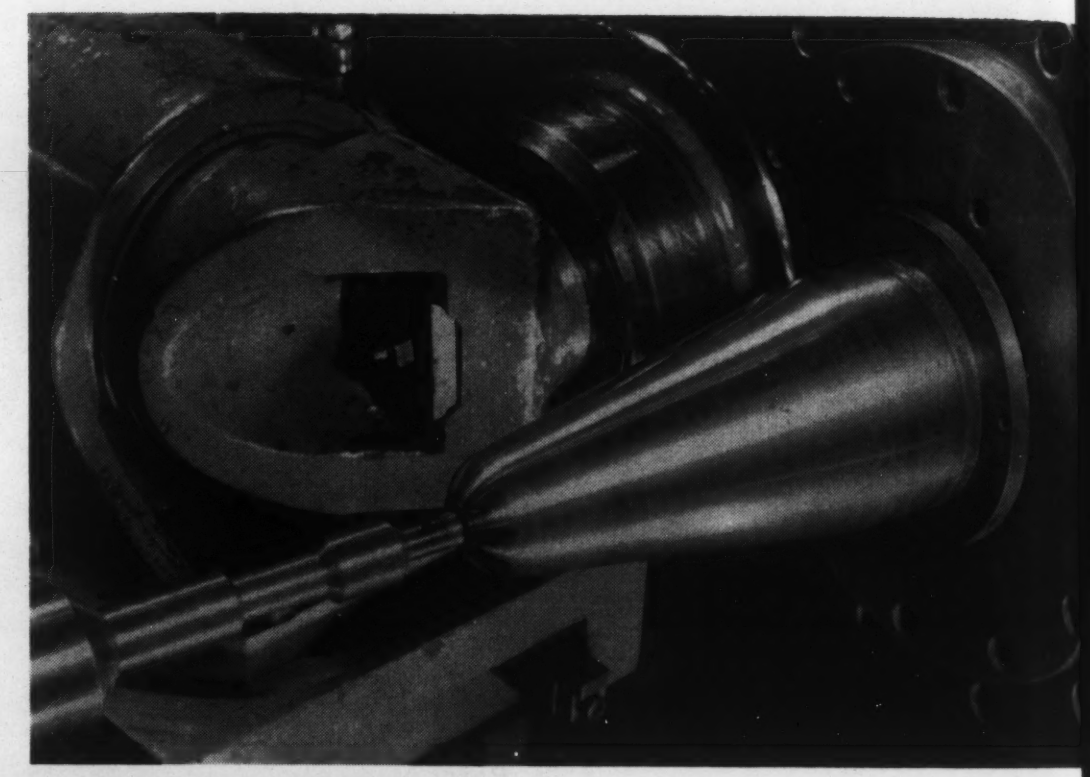
Stainless steel nose cone for U. S. earth satellite

Complete details have recently been released on the materials and processes involved in the production of the Explorer earth satellite's nose cone.

According to the Committee of Stainless Steel Producers, American Iron & Steel Institute, the nose cone is made of type 430 stainless and is 12 in. long and 6 in. wide at its maximum. Stainless was selected because of its high tensile strength, good resistance to temperature extremes and excellent corrosion resistance.

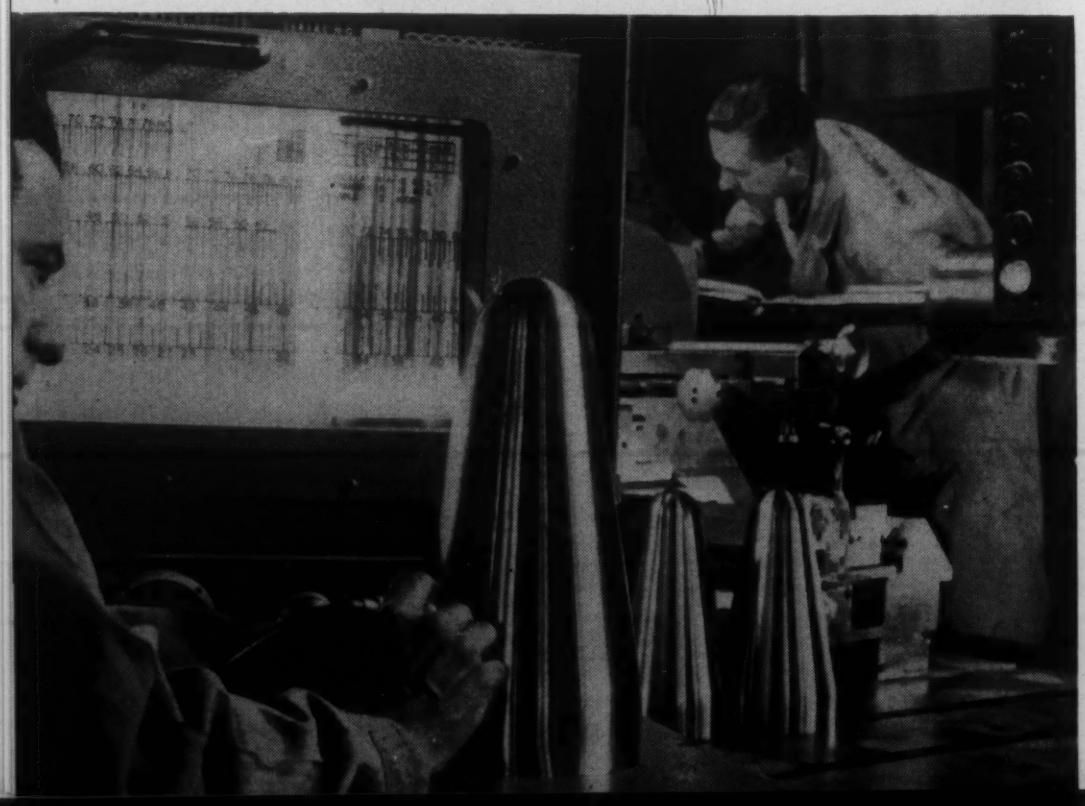
Wall thickness of the nose cone ranges from 0.013 to 0.017 in.; the middle of the blunt nose is 0.094 in. thick. The cone's weight before assembly on the instrument package is 13 oz. Sixteen equally spaced ⅛-in.

(continued on p 188)



4. Part is formed to final dimensions.

5. Wall thickness is tested with ultrasonic resonance gage.



MORE MATERIALS AT WORK

Carbide provides rough surface 188

Chipboard grille-work makes filter stronger..... 188

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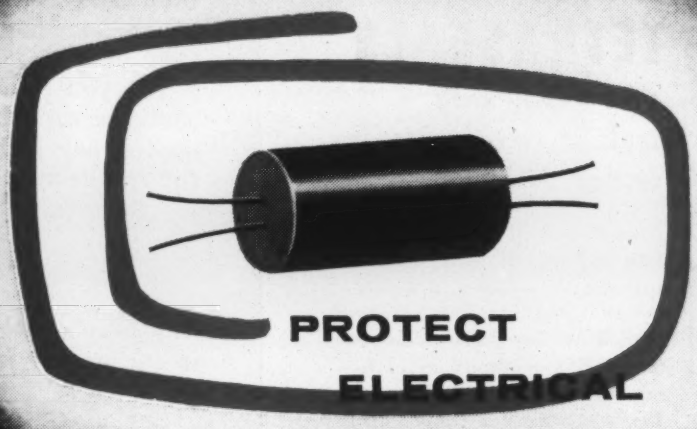
First all-glass case for transistor units 192

Giant phenolic duct..... 194

CRITICAL COMPONENTS ENCASED IN

RCI EPOTUF RESINS



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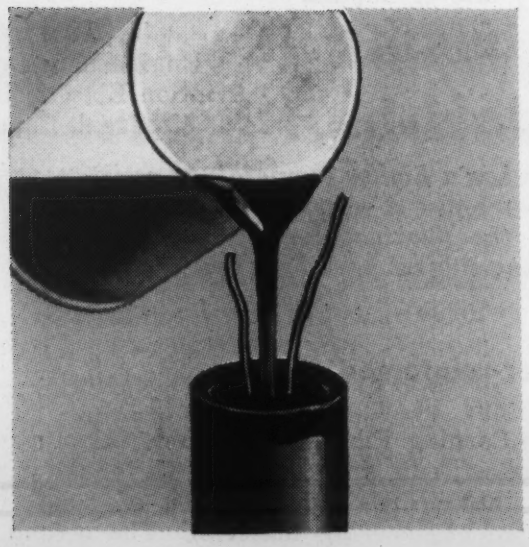

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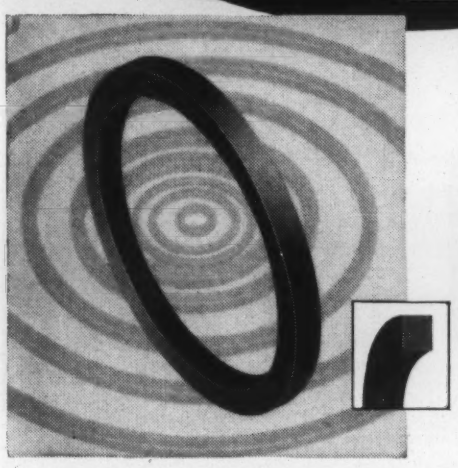

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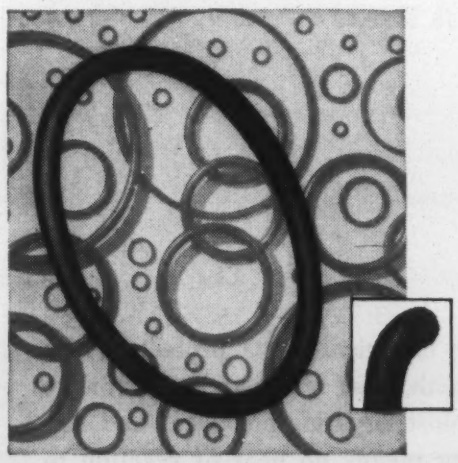

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For more information, turn to Reader Service card, circle No. 450

Aluminum casting tolerances

To the Editor:

I enjoyed your very excellent manual, "Aluminum Alloy Castings," in the February issue.

I have one question regarding the tolerances that can be held with aluminum die castings. On p 134 you indicate that minimum tolerances on die castings are about ±0.002 in. Are these tolerances quoted per inch of the part or per foot as reported for sand castings and permanent mold castings?

DAVID L. DENNISON
E. I. du Pont de Nemours & Co., Inc.
Wilmington 98, Del.

The copy should have stated that the tolerances were in inches per inch.

High temperature plastics

To the Editor:

We are developing a high pressure air relief valve (5000-6000 psi) and have been successful at room and low temperatures with Kel-F 300 in combination with steel. Unfortunately this plastic loses its resilience and resistance to sonic air flow when 100 F is exceeded.

The problem is to find a plastic which approximates the characteristics of Kel-F or Teflon, but has better resistance to increased temperatures (about 150-220 F) and/or impact.

T. SUMMERS
Engineering Dept.
Aviation Electric Ltd.
Montreal, Canada

No plastic has a higher temperature resistance than the fluorocarbons. A possibility is reinforced Teflon or one of the fluorinated elastomers. Article tear sheets on the subject have been mailed.

Glass fiber-reinforced plastics

To the Editor:

Owens-Corning Fiberglas has undertaken a program to collect, edit and distribute to industry, design data that will aid in the use of reinforced plastic as an engineering material. The second in the series of manuals is entitled "Mechanical Fastening and Machining of Fibrous Glass Reinforced Plastics," senior editor, T. B. Blevins. Material is now being collected and the manual should be published at the end of this year.

We would appreciate your help in collecting this data through an article in your publication which would mention the subject of the book, and a statement that any photographs, reports or other data would be most welcome. Full credit (company

Tool Steel Topics

BETHLEHEM STEEL

Some Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

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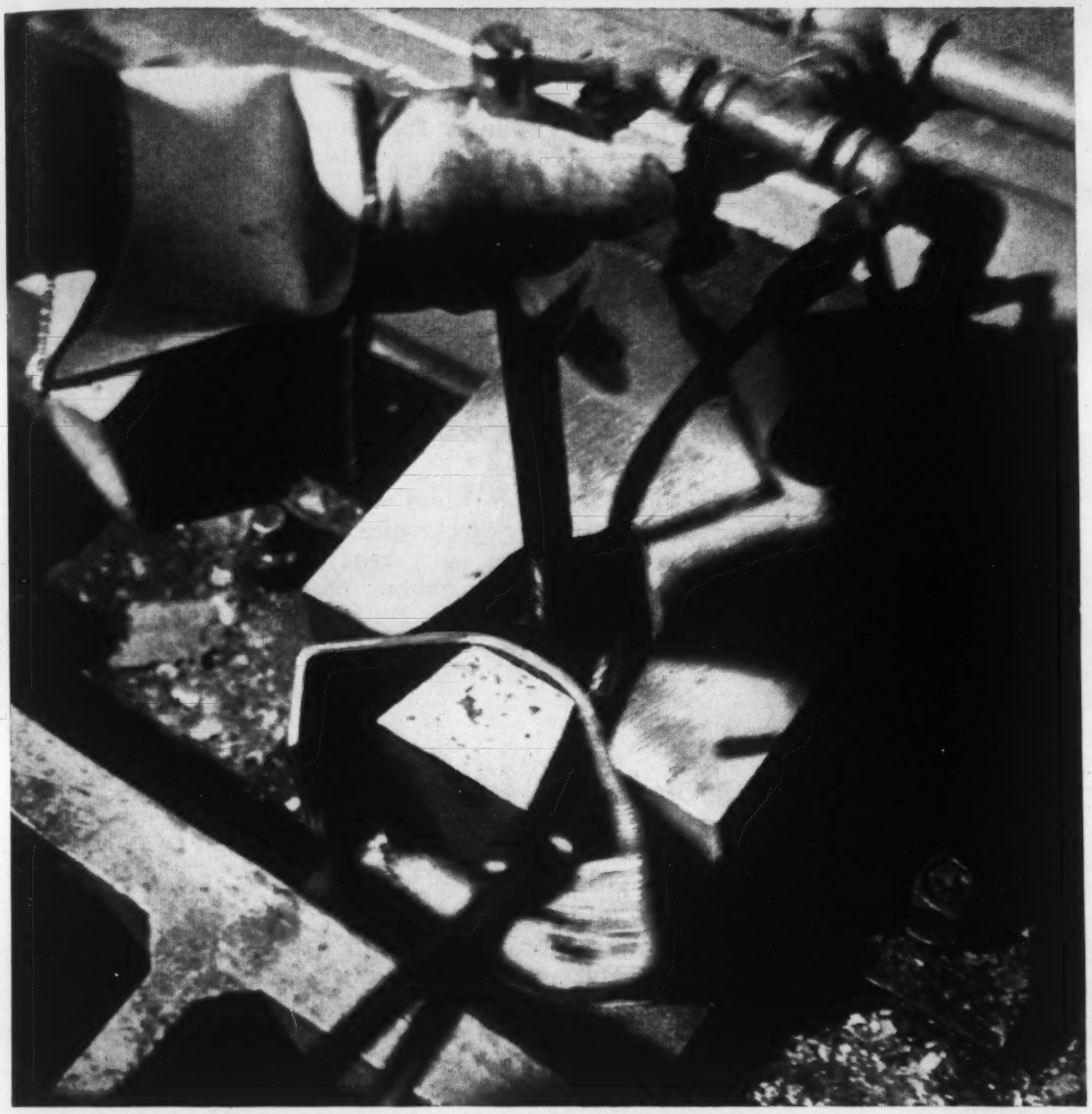

Highway Guard Rail Brackets Formed Red-Hot with Cromo-W

The product is a steel offset bracket, ¼ in. thick. It's used for fastening wire rope to highway guard rail posts. The bracket is formed red-hot, with a two-stage die of Bethlehem Cromo-W tool steel. Between 90,000 and 100,000 pieces are produced before redressing becomes necessary.

Cromo-W has a 5 pct chromium content and is one of our most popular general-purpose tool steels for a variety of hot-work applications. It offers good red-hardness and high shock-resistance. It also has good resistance to heat checking when cooled drastically during high-temperature operations, and is easy to machine and heat-treat.

Cromo-W is an ideal grade of tool steel for such diversified uses as die casting dies, bolt-gripper and bolt-header dies, trimmer dies, punches, and hot shear blades. In fact, it's a grade you can count on for long service in virtually any manufacturing operation involving severe shock and temperature change.

Typical Analysis

Carbon 0.35	Tungsten 1.55
Silicon 1.05	Molybdenum 1.65
Chromium 5.15	

In addition to Cromo-W, Bethlehem offers Cromo-WV and Cromo-High V for die casting and extrusion work. See your Bethlehem tool steel distributor for full details on these fine hot-work grades.

General view of the forming operation. Cromo-W is ideal for this hot-work application because of its good red-hardness and high shock-resistance.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Machining is a Tearing Operation

Close examination of the surface of a machined part, or chips machined from it, indicates the presence of countless minute tears. Generally, the tears can be seen most readily on parts machined at low speeds, with heavy feed and depth of cut. However, they are also present in all machined surfaces, even though not readily visible. The depth of surface tears on smooth machined tools and dies may be approximately one thousandth of an inch, or less. For this reason, the presence of the tears and their possible effects are often overlooked.

Most tools are heat treated after machining. Then they are ground all over to produce the exact dimensions, and to remove scale or decarburization resulting from the hardening operation. This procedure automatically removes tears in the surface previously produced during machining. However, many tools are ground only on certain portions, with the balance of the tool surfaces containing the remains of the machining tears, plus heat treatment scale and decarburization. This condition occurs often when you grind only the actual working surfaces which make contact with the parts. Tools produced by this method are more susceptible to failure in service because of stress concentration produced by the sharp change of section in the tears. This is particularly true of tools subjected to a large number of stress cycles in service, such as pneumatic tools.

Grinding all previously machined surfaces of tools after hardening is an operation which helps improve production from the tools. Grinding before hardening will also be effective, should grinding after hardening be inconvenient.

For more information, turn to Reader Service card, circle No. 511

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HIGH TEMPERATURES . . .
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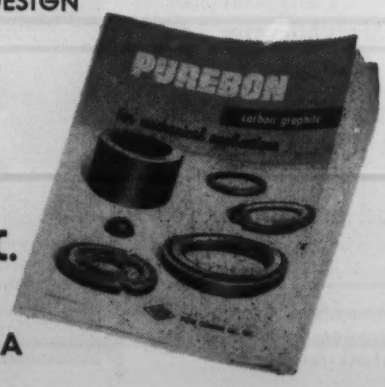

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and personal) and a free copy of the book goes to everyone contributing material that is used in the book.

All material should be sent to my attention.

MARSHALL D. WEISS
Owens-Corning Fiberglas Corp.
Reinforced Plastics Laboratories
Ashton, R. I.

Gallium for heat transfer

To the Editor:

Some time ago there was mention made in one of the aviation or electronics publications regarding the use of gallium as a heat transfer material in some type of atomic engine, possibly one under development for aircraft. Do you have any information regarding this or other uses of gallium?

PAUL W. STUEHN
LaDriere Studios, Inc.
Detroit 26, Mich.

We do not but our readers may.

Closed-cell foams

To the Editor:

We are interested in your article, "Thermal Insulation Materials," in the Mar '58 issue. On p 136 you make reference to closed-cell polyvinyl chloride in soft sheets and to synthetic cellular rubbers (closed cells). We are interested in finding a source of closed cell foam suitable to withstand transformer oil. Buna N rubber or possibly polyvinyl chloride should be satisfactory.

E. F. HUSTON
Development Engineer
Ohio Brass Co.
Barberton, Ohio

Two suppliers of Buna N closed-cell insulation are: Sponge Products Div., B. F. Goodrich Co., Shelton, Conn., and Rubatex Div., Great American Industries, Inc., Bedford, Va. The same division of Goodrich also supplies closed-cell polyvinyl chloride.

Seamless aluminum tubing

To the Editor:

We are trying to locate sources of supply of seamless extruded aluminum tubing in diameters from 2 to 8 in. Various suppliers furnish a welded tube but for our use in astronomical telescopes this will not do. At present our material is purchased from an irrigation supply distributor. Price is a factor in locating new sources.

E. C. HOUGHKIRK
Manager of Manufacturing
Edmund Scientific Co.
Barrington, N. J.

We suggest contacting Mr. Floyd Lewis, Aluminum Assn., 420 Lexington Ave., N. Y.

ONE POINT OF VIEW

Let's have better education on materials

The recently revived interest in education has generated, among other things, a close review of engineering curricula. We would like to advance the suggestion that in these curricula studies the extent and quality of courses on engineering materials should not be overlooked.

Pertinent courses needed . .

The quality and amount of formal education on materials an engineer receives in college varies widely. Frequently the only materials information the student receives is what he picks up from various unrelated courses, such as chemistry and metallurgy. Valuable as these courses may be, they are largely concerned with the chemical or metallurgical nature and structure of materials, and do not provide the student with practical information on service properties and end uses.

It is true that the curricula at a substantial number of schools include one required general course on engineering materials. Where this is the practice, we are not advocating additional required courses. Rather, we would like to see the present required courses improved to provide more useful information to those engineers who are not specializing in materials.

Too many of the courses are now obsolete. The common course on engineering materials is a broad descriptive survey that tries to cover everything about all materials. Frequently, at least one-third of the course is devoted to topics such as mineral dressing, extractive metallurgy, blast furnace and rolling mill practice. Although a broad knowledge of materials production practice may be important to a few, the great majority of students during their professional careers will be concerned more often with the selection and application of materials.

. . . to educate the user

For this reason, general courses on engineering materials should be planned for the *user* and not the producer of materials. Without the materials production aspects, the courses could more adequately cover the principles of material selection, the engineering and service properties, and the processing and fabricating characteristics of all the important engineering materials. Some time might also be available to go beyond the "standard" materials and give the student a quick resume of the latest developments in the field.

Only through such a course, can the engineer and designer be prepared properly to select materials for the products he will be called upon to plan, design and produce.

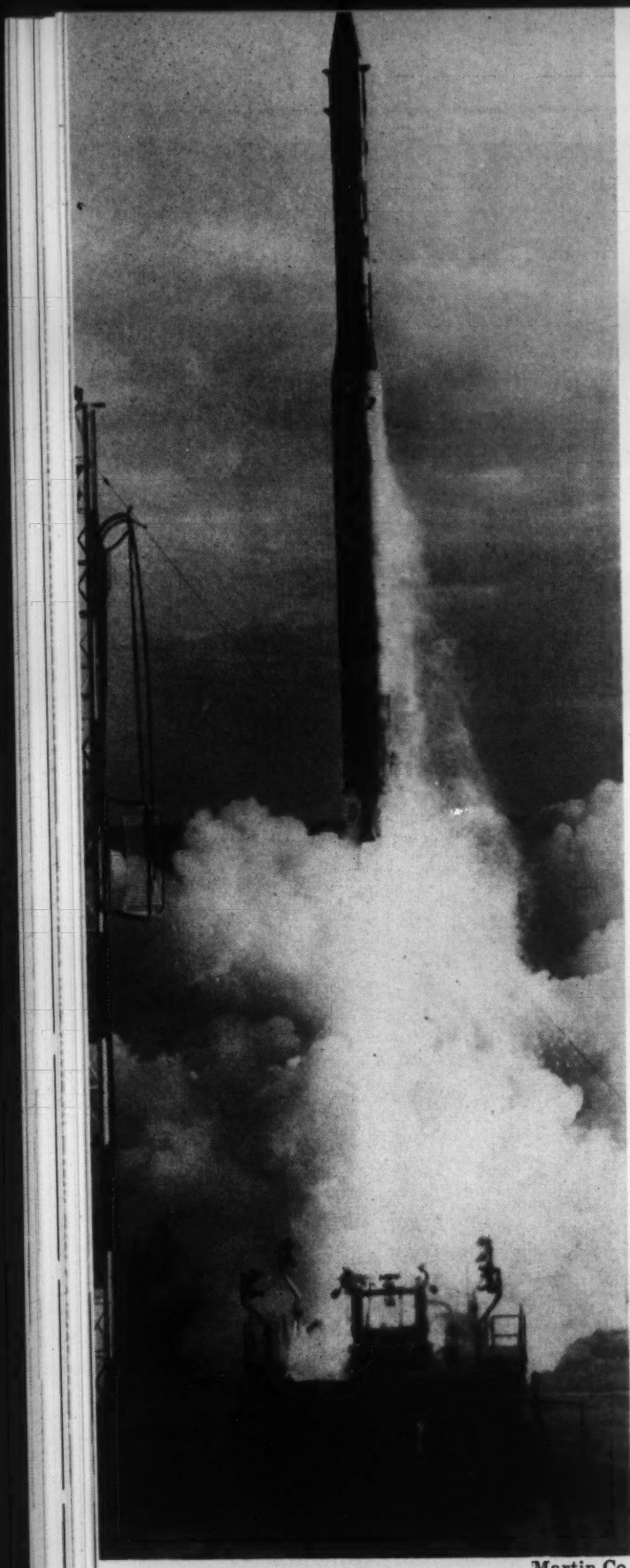
Reinforced Plastics at 3,000 to 25,000 F

A great deal of misleading information has been circulated about high-temperature-resistant reinforced plastics for rocket and missile components. Just how good are they under these 'impossible' service conditions? Here is as much as we know today.

by Malcolm W. Riley, *Associate Editor, Materials in Design Engineering*

■ The problem of selecting materials for service at temperatures ranging from 3000 to 25,000 F and at extremely high gas velocities is unique to rocket and missile design. Materials for rocket components may be subjected to two general types of environments: 1) internal combustion temperatures up to about 5000 or 7000 F and erosion by hot gas streams composed of combustion products, or 2) external skin friction caused by ram air, producing in some cases much higher temperatures—possibly up to around 25,000 F. (Though no temperature values for reentrance into the atmosphere have been released, GE's fluid stabilized arc, used to test materials for this type of service, produces plasma temperatures of from 12,000 to 25,000 F.)

No structural material known will withstand even the lower internal combustion temperatures continuously; the problem is to choose a material that will *postpone* structural failure for the duration of service. In the case of rockets, time of exposure to such high temperatures may range from several seconds to several minutes, or, in some rare instances (in the lower temperature range), up to 1 hr. For exposures of such length and at such temperatures, certain reinforced plastics are superior to metals and, in many cases, ceramics; reinforced plastics pyrolize, but their decomposition rate is usually slower than that of metals. This finite decomposition time can delay structural failure of the material for the relatively brief duration of service encountered in missiles. This decomposition mechanism is called *ablation* (i.e., a wearing away) in recognition of the finite time during which erosion and decomposition take place.

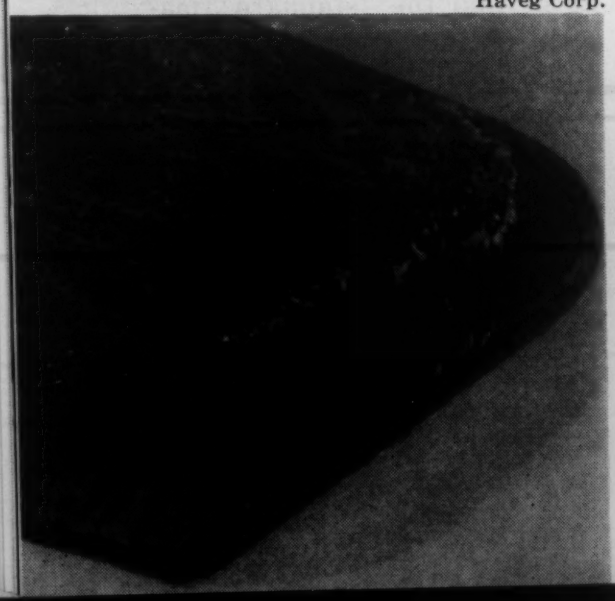


Martin Co.

***Vanguard**, shown taking off, has a number of reinforced plastics parts in several of its component rockets.*

***Ablation** of a fin for the Corporal missile is shown here in close-up after testing.*

Haveg Corp.



Why plastics are better

The rationalization that seems to explain the low erosion rate of certain reinforced plastics at these high temperatures and high gas flows is rather well developed, although the relative importance of each of the factors involved in the complex process is not established. Put very simply, the three characteristics that seem to be responsible for the high temperature erosion resistance of reinforced plastics are 1) high heat capacity, 2) capacity to generate surface gas on heating, and 3) low thermal conductivity.

Heat capacity

The accompanying table shows integrated specific heats (80 to 8500 F) of a variety of materials. Of the structural materials shown,

organic plastics have the highest values. Since hydrogen has the highest specific heat of any material, the addition of more hydrogen to the hydrocarbon plastic molecule should increase the thermal capacity of the material. Thus, the high heat capacity of hydrogen would seem to explain why organic fibers with high hydrogen contents are such successful reinforcing materials. Reinforcements consisting of nylon fibers have been quite successful. Possibly fibrous materials such as polypropylene or polyethylene with higher hydrogen contents than nylon may give even better results. Another approach to providing additional hydrogen content that has met with some success is the use of hydrides as filler materials.

A second method of providing higher heat absorbing capacity during service is to select a material of such composition that at pyrolysis temperatures any chemical reaction is endothermic to the maximum degree. For example, when high silica glass-reinforced phenolic materials are exposed to these temperatures an endothermic reaction seems to occur.

SOME THERMAL CHARACTERISTICS OF MATERIALS

Material ↓	Heat Absorbed, Btu/lb[a]	Rel Gas Vol, moles/gm[b]
Hydrogen Gas (H_2)	67,000	1.0
Organic Plastic $(CH_2)_n$[c]	24,000	0.21
Organic Plastic $(CH)_n$[c]	20,600	0.15
Graphite	16,670	0.08
Water	14,500	0.16
Beryllium	9,876	0.11
Beryllia (BeO)	7,080	0.08
Teflon $(C_2F_4)_n$	6,300	0.06
Cellulose $(C_6H_{12}O_6)_n$	5,760	0.10
Magnesia (MgO)	5,500	0.05
Helium	3,525[d]	0.25
Silica (SiO_2)	2,800	0.05
Copper	1,600	0.016

[a]Estimated integrated specific heats from 80 to 8500 F.
[b]Equilibrium volume of gas generated at 8500 F.
[c]Heats of formation of some hydrocarbons are negligibly small. Values here are for elementary hydrogen and carbon in appropriate proportion.
[d]Low value emphasizes important contribution from hydrogen dissociation in some of other materials.
Source: *Gruntfest and Shenker* (ACS paper).

Gas generation

Since the heat in an extreme-high-temperature environment is transferred to the material by both radiation and convection, any gases generated by the material should interfere with convective heat transfer and might also act as a radiation barrier. The table shows the volume of gas generated by various materials at 8500 F under equilibrium conditions. Of the structural materials, organic plastics generate the most gas per given weight of material. Since hydrogen has the highest gas generation rate, it appears that increasing the hydrogen content of the material should increase not only its heat absorption capacity but also its gas generation rate.

Thermal conductivity

Low thermal conductivity in the structural material is desirable to limit temperature effects to the surface area and retard the progress of decomposition through the material. Limiting the heat penetration also results in higher surface temperatures which may 1) provide a closer approach to thermal equilibrium (see discussion below), and 2) increase radiation from the surface back to the environmental gases.

The effects of the lower thermal conductivity of organic fiber reinforcement can be clearly seen in comparing exposed cross-sectioned specimens of organic fiber-reinforced and glass fiber-reinforced specimens. The organic fiber-reinforced specimen generally has a much thinner, more cleary defined charred area. In any case, the relatively low thermal conductivity of reinforced plastics limits the depth of the affected zone, and the unaffected zone has essentially the same properties as the material had at room temperature.

Thus, in designing reinforced plastics for such service, section thickness should consist of the thickness required structurally (as determined by room temperature properties) plus the expendable thickness of material that will be affected by the heat. Unfortunately, sufficient information is not yet available to permit reliable predictions of the depth of penetration of the heat-affected area for different materials under specific conditions.

What About the Commercial Materials?

Most of the commercial reinforced plastics publicized as particularly developed for rocket and missile use seem to be intended for the temperature range of 3000 to 10,000 F. Of the commercial materials whose compositions are disclosed, most are phenolic with either asbestos or silica glass reinforcement. Materials suppliers are definitely handicapped by security limitations, and no objective test results of proprietary materials are releasable. Claims by suppliers would indicate that behavior of the materials are of the order of magnitude indicated by the data in this article.

For example, erosion rates for certain asbestos-phenolic proprietary materials are reported to be 0.0052 to 0.0072 in. per sec on flat panels exposed to combustion temperatures of 4700 F and gas velocities of Mach 2.5.

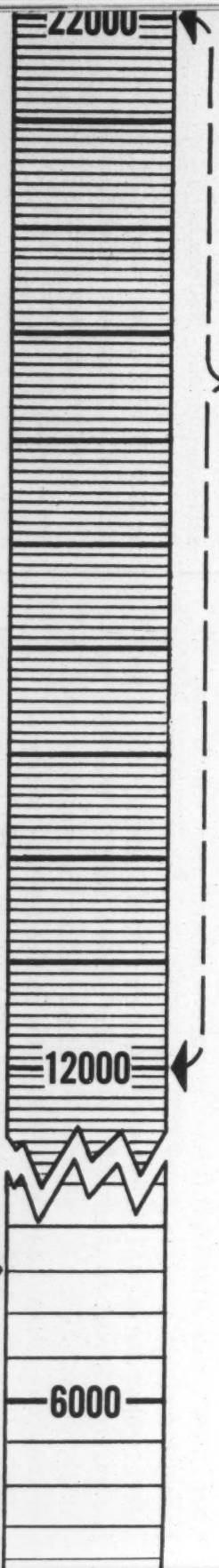
Another supplier compares his high silica glass-reinforced phenolic material with glass and asbestos-phenolic materials on the basis of burn-through time at 4500 F with a gas velocity of Mach 0.5. Time and thickness for burn-through are given approximately as follows: 1) high silica glass-phenolic: 200 sec for 0.80-in. thickness, 2) asbestos-phenolic: 180 sec for 0.85-in. thickness, and 3) glass-phenolic: 140 sec for 195-in. thickness. These values are compared with a burn-through time for steel of 80 sec for a 1-in. thickness.

Another major supplier, again limited by security restrictions, claims that a ½-in. thick disk of material (resin and reinforcement undisclosed) shows "very little erosion and no cracking" after 20-sec exposure to temperatures ranging from 9000 to 12,000 F.

Here's how they perform

How Reinforced Plastics Perform at High Temperatures

Here is what the unclassified data show so far



6300 F—*Oxyacetylene torch, 30 sec.*

Silicone resins—glass mat-reinforced or magnesium oxide-filled—are superior to both styrene and TAC-type polyesters.

6300 F OXYACETYLYNE TORCH—30 SEC
(Weight Loss, %)

Reinforcement or Filler ↓ Resin →	TAC-Polyester	Styrene-Type Polyester	Silicone	Phenolic
Glass Fiber (mat)	34	38	24	—
Aluminum Oxide(hydrated)	53	53	46	—
Aluminum Oxide	100	100	30	—
Magnesium Oxide	33	65	8	—
Boron Carbide	59	87	17	—
Aluminosilicate	—	—	41	—
Asbestos Fiber	—	—	63	29
Milled Glass Fibers	—	—	55	—
Glass Cloth (horiz orientation)	—	—	39	—
Glass Cloth (vert orientation)	—	—	48	—
Asbestos Cloth (horiz orientation)	—	—	57	—

Source: *Gruntfest and Shenker* (SPI paper).

12,000-22,000 F—*Water-stabilized arc, 10 sec.*

Organic fiber-reinforced phenolics show lowest weight loss of plastics. In glass-phenolics lowest glass contents are best.

22,000 F STABILIZED ARC—10 SEC
(Weight Loss, Mg/Kw-Sec Heat Input)

Glass Cloth-Phenolic	
Chopped Cloth-Resin C	6.7
Chopped Cloth-Resin D with—	
27% Resin	2.7
37% Resin	2.2
44% Resin	2.2
65% Resin	1.5
Chopped Silica Glass Cloth-Phenolic Resin D (41% resin)[a]	2.3
Organic-Reinforced Phenolic	
Orlon Fiber-Resin D	1.3
Chopped Nylon Cloth-Resin D (57% resin)	1.1
General Purpose, Woodflour-Filled Molding Compound	5.3
Asbestos-Phenolic	
Acid Leached Asbestos-Resin E	2.1
Acid Leached Asbestos-Resin F	2.9
Asbestos Mat-Resin G	6.3
Molding Compound (resin H)	7.0
Molding Compound (resin G)	6.5
Chopped Fabric-Resin I	2.1
MIL Type MFG Molding Compound	2.4
Molding Compound (resin K)	1.7
Graded MgO-Filled Phenolic	1.8
Graphite-Filled Phenolic Molding Compound	1.7
Glass Fiber-Melamine (NEMA Grade G-5[b])	
Supplier No. 1	5.4
Supplier No. 2	3.6
Cotton-Melamine (NEMA Grade MC)	2.6
Glass Fiber-Silicone	
NEMA Grade G-7	3.3
Chopped Fiber-Filled Molding Compound	2.9
Glass Fiber-Epoxy	
Electrical Grade Laminate	2.3
Epoxy-Pyromellitic Dianhydride in Glass Fibers (31% resin)	3.0
Hard Rubber—	
No Carbon	2.8
60% Carbon	4.0
Vulcanized Fibre	2.7
Copper Rod	60.0
Graphite (good grade)	0.9

[a]High silica glass was Refrasil, trademark of H. I. Thompson Fiber Glass Co.
[b]Medium weave glass cloth.
Source: *Gruntfest and Shenker* (SPI paper).

4500-5400 F—*Oxygen-city gas torch (unspecified time)*

Organic fiber-reinforced resins show lower weight loss (even before scraping) than the same resins reinforced with glass. Of resin binders, silicones are best, then melamines, phenolics and epoxies.

4500-5400 F IN OXYGEN-CITY GAS TORCH—30 SEC (Weight Loss, Gm/Sec)

Material ↓	Before Scraping	After Scraping
Phenolic Reinforced with—		
Orlon	0.015	0.018
Nylon (NEMA Grade N-1)	0.017	0.019
Asbestos (NEMA GradeAA)	0.015	0.030
Glass (NEMA Grade G-3)	0.019	0.032
Cotton (NEMA Grade LE)	0.023	0.026
Paper (NEMA Grade XX)	0.024	0.026
Epoxy Reinforced with—		
Glass (NEMA Grade GEE)	0.013	0.026
Orlon	0.031	0.032
Melamine Reinforced with—		
Glass (NEMA Grade G-5)	0.012	0.034
Cotton (NEMA Grade MC)	0.020	0.022
Silicone Reinforced with Glass (NEMA Grade G-7)	0.003	0.029
Diallyl Phthalate Reinforced with—		
Glass	0 014	High
Orlon	0.020	Low
Dacron	0.020	Low

Source: *Gruntfest and Shenker* (SPI paper).

4300 F[a]—*Solar furnace (at flux density of 200 Btu/sec/sq ft), 60 sec.*

Nylon-phenolic and glass-phenolic show lowest erosion rates. In vacuum, glass-silicone is best; glass-epoxy is much better than when tested in air.

[a] Calculated black body temperature.

4300 F IN SOLAR FURNACE—60 SEC (Weight Loss, Gm/Sec)

Phenolic-Glass (NEMA G-3)	0.0145
Phenolic-Nylon (NEMA N-1)	0.0149
Epoxy-Glass (Type GEE)	0.0166
Phenolic-Asbestos (NEMA AA)	0.0167
Phenolic-Cotton (NEMA LE)	0.0244
Phenolic-Paper (NEMA XX)	0.0275
Vulcanized Fibre (cellulose)	0.0339
Silicone-Glass (NEMA G-7)	0.0344
Phenolic-Orlon	0.0412

Source: *Gruntfest and Shenker* (SPI paper).

Text of article continues on p 104

5000
4000
3000
2000

2700-5000 F IN SOLAR FURNACE—60 SEC[a]

Material ↓	Air Atmosphere			Vacuum[b]				
	Weight Loss, gm/sec		Weight Loss Ratio, max/min	Weight Loss, gm/sec		Weight Loss Ratio, max/min	Pressure Diff During Run, mm Hg	
	At Min Flux	At Max Flux		At Min Flux	At Max Flux		At Min Flux	At Max Flux
Phenolic-Asbestos (NEMA AA)	0.00850	0.03750	4.42	0.00448	0.01819	4.09	34.6	426.0
Epoxy-Glass (Type GEE)	0.00830	0.03540	4.27	0.00446	0.1372	3.10	23.9	265.9
Silicon-Glass (NEMA G-7)	0.00860	0.05820	6.77	0.00064	0.00616	9.62	29.3	270.5
Phenolic-Paper (NEMA XX)	0.01050	0.04810	4.58	0.00408	0.01955	4.30	32.8	398.7
Phenolic-Glass (NEMA G-3)	0.00560	0.04500	8.04	0.00200	0.01256	6.28	53.3	394.0
Vulcanized Fibre	0.01160	0.05740	4.94	0.00543	0.04850	8.94	80.0	298.0
Phenolic-Nylon (NEMA N-1)	0.00590	0.03220	5.46	—	0.01850	—	—	407.0
Phenolic-Orlon	0.00950	0.0612	6.44	0.00784	0.04920	6.29	36.7	260.8

[a]Minimum flux=40 Btu/sec/sq ft, corresponding to black body temperature of 2700 F. Maximum flux=430 Btu/sec/sq ft, corresponding to black body temperature of 5000 F.
[b]Tests were run in vacuum chamber to better study pyrolysis mechanism. Pressure differential measurements indicate gas generation at high temperatures.
Source: *Gruntfest and Shenker* (SPI paper).

5000 F[a]—*Solar furnace (at max flux density of 430 Btu/sec/sq ft), 60 sec.*

Nylon-phenolic, glass-epoxy and asbestos-phenolic show lowest erosion rates. In vacuum, glass-silicone is best.

2700 F[a]—*Solar furnace (at min flux density of 40 Btu/sec/sq ft), 60 sec.*

In air, nylon-phenolic and glass-phenolic show lowest erosion rates. In vacuum, glass-silicone and glass-phenolic show lowest erosion rates; nylon-phenolic has not been tested.

[a] Calculated black body temperature.

3000 F JET AFTERBURNER—12-60 SEC (Rating[a])

Material ↓	Thermal Stability				Strength		Average Ratings
	Weight Loss	Depth of Charring	Surface Erosion	Delamination	Exposed Area	Non-Exposed Area	
Glass-Phenolic	3	3	3	1	2	2	2.33
Asbestos-Phenolic	2	2	2	2	1	1	1.67
Glass-Silicone	1	1	1	3	3	3	2
Glass-Polyester	4	4	4	4	4	4	4

[a]Optimum material in each case is rated No. 1.
Source: *Miller and Strauss.*

3000 F—*Jet engine afterburner exhaust, 12-60 sec.*

Silicone-glass is most stable. Asbestos-phenolic and glass-phenolic retain fair degree of structural integrity. Asbestos-phenolic shows higher strength but lower thermal shock resistance than glass-phenolic.

Problems in using the theoretical approach

The theory of maximum heat absorption and gas generation is inadequate, in itself, for selection of specific materials because of the non-equilibrium nature of the process. The surface of the material in actual service rarely, if ever, reaches thermal equilibrium with its environment; thus maximum thermal efficiency is not obtained. As the surface of the material melts or vaporizes (depending on the material), the liquid or gaseous products are swept off the surface by the high velocity gas stream. Of course, the higher the viscosity of the fluids (if the material melts), the more stable the fluid coating, and the closer the surface may come to thermal equilibrium. Thus, at temperatures near 5000 F, silica glass reinforcements melt, and the high viscosity, molten silica tends to cling to the surface of the material.

One possible reason for the success of resins such as phenolics is that at high temperatures the decomposition products are simple gases and a carbon residue. The carbon residue may protect the underlying material from the hot gases of the environment, and may also provide a hot reaction zone in which the primary gaseous products are brought closer to thermal equilibrium.

Which plastics are better

It is too early to say definitely which reinforced compositions should be used for a given service condition. Test methods leave much to be desired, releasable data are spotty, and the objective data available should be considered qualitatively rather than quantitatively. The comparative data on pp 102 and 103 indicate which materials appear to be most promising after exploratory testing. The following tentative conclusions seem valid in the development of design information.

Phenolic materials

1. In general, phenolic resins provide the lowest erosion rates. However, in a group of phenolic materials from various suppliers there is as much variance in erosion rates as there is in groups composed of different resins such as silicones, melamines and epoxies.

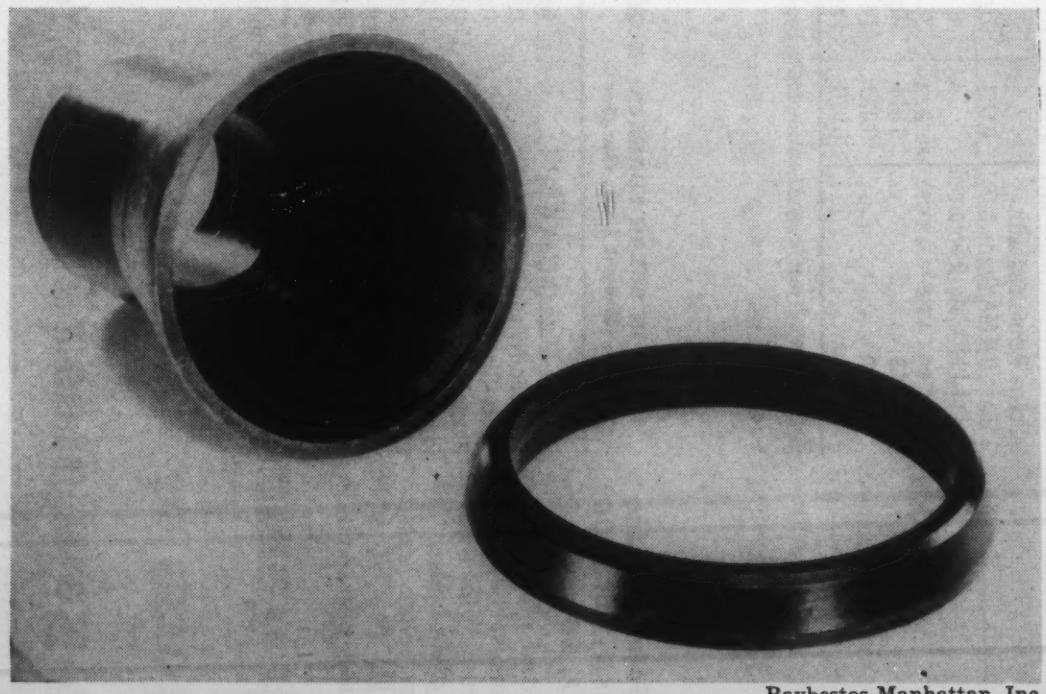
2. At the extremely high (12,000 to 22,000 F) temperatures, phenolic resins with organic reinforcements such as nylon or acrylic fiber seem to provide the best results. In glass-phenolic compositions, the lower the glass content the lower the erosion rate; this can be explained by the theory discussed above.

3. In the lower temperature range (4000 to 5400 F), phenolics reinforced with high silica glass fibers or asbestos provide lower erosion rates in some cases than phenolics reinforced with organic fibers. Also, the higher glass content materials are generally better than those with lower glass content; evidently, at these temperatures the high silica glass "sweats" out and coats the surface with silica, increasing thermal efficiency of the protective mechanism.

Other resin systems

1. Although in some cases erosion rates for glass-silicone materials are quite low, at relatively low temperatures (3000 F), the materials themselves are relatively low in structural strength. Some test values have been similar to those for the better phenolics.

2. Results with epoxy resin systems have not been too promising except in one case. However, published test information has not been based on epoxy materials particularly formulated for high temperature erosion resistance.



Raybestos-Manhattan, Inc.

Two asbestos-phenolic parts, *a throat insulator and a grain ring, are used in direct contact with solid rocket propellant.*

Acknowledgments

The author would particularly like to express his appreciation to Dr. J. Lux, Haveg Corp.; F. W. Jahns, Continental Diamond Fibre Corp.; Drs. I. J. Gruntfest and L. H. Shenker, Missiles and Ordnance Div., General Electric Co.; P. Fina, Fiberite Corp.; Dr. W. Brenner, Consultant and D. V. Rosato, Reinforced Plastics Div., Raybestos-Manhattan, Inc.; as well as H. I. Thompson Fiber Glass Co. and Taylor Fibre Co.

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Much of the information and data for the article was obtained from the following papers:

Gruntfest, I. J., and Shenker, L. H., "The Behavior of Reinforced Plastics at Very High Temperatures," presented at 13th Annual Meeting, Reinforced Plastics Div., Society of The Plastics Industry, Inc., Feb '58.

Gruntfest, I. J., and Shenker, L. H., "Behavior of Materials at Very High Temperatures," presented before the Paint, Plastics and Printing Ink Div., American Chemical Society, Apr '58.

Miller, N. B., and Strauss, E. L., "Effects of Elevated Temperature and Erosion on Reinforced Plastic Laminates," presented at 13th Annual Meeting, Reinforced Plastics Div., Society of The Plastics Industry, Inc., Feb '58.

Selecting Bearing Metals That Will Not Seize

by C. L. Goodzeit, *Senior Research Engineer, General Motors Corp.*

This table and the following discussion give you the information you need to select pairs of bearing metals that will not form strong welded junctions during operation.

SEIZURE RESISTANCE OF PAIRS OF METALS[a]

Metal Pair → ↓	1045 Steel		Aluminum		Copper		Silver	
	Pair Type	Rating	Pair Type	Rating	Pair Type	Rating	Pair Type	Rating
Aluminum	M	P	M	P	M	P	M	P
Antimony	C	F-G	C	F-G	M	F	—	—
Barium	I	P	—	—	—	—	—	—
Beryllium	M	P	M	P	M	P	M	P
Bismuth	I	F-G	I	F-G	I	F-G	—	—
Cadmium	I	F-G	I	F-G	—	—	—	—
Calcium	I	P	M	P	M	P	—	—
Carbon	C	F-G	I	P	I	P	I	P
Cerium	M	P	M	P	M	P	—	—
Chromium	M	P	M	P	I	F-G	I	F-G
Cobalt	M	P	M	P	M	P	I	F-G
Columbium	M	P	M	P[b]	M	P[b]	I	F-G
Copper	M	F	M	P	M	P	M	P
Germanium	C	F-G[b]	—	—	—	—	—	—
Gold	M	P	M	P	M	P	M	P
Indium	I	F-G	I	F-G	M	P	M	P
Iridium	M	P	—	—	—	—	—	—
Iron	M	P	M	P	I	P[b]	I	F-G
Lead	I	F-G	I	F-G	I	F-G	I	F-G
Lithium	I	P	—	—	—	—	—	—
Magnesium	I	P	M	P	M	P	M	P
Manganese	M	P	—	—	—	—	—	—
Molybdenum	M	P	M	P[b]	M	P[b]	I	P
Nickel	M	P	M	P	M	P	I	P
Palladium	M	P	—	—	—	—	—	—
Platinum	M	P	M	P	M	P	—	—
Rhodium	M	P	M	P	M	P	—	—
Selenium	C	F-G	C	P	C	F-G	—	—
Silicon	M	P	M	P	M	P	M	P[b]
Silver	I	F-G	M	P	M	P	—	—
Tantalum	M	P	M	P	M	P	—	—
Tellurium	C	F-G	C	F-G	C	F-G	—	—
Thallium	I	F-G	I	F-G	I	F-G	—	—
Thorium	M	P	M	P	M	P	M	P[b]
Tin	C	F-G	M	P	M	P	—	—
Titanium	M	P	M	P	M	P	I	F-G[b]
Tungsten	M	P	M	P	M	P	—	—
Uranium	M	P	M	P	M	P	—	—
Zinc	M	P	M	F	M	P	—	—
Zirconium	M	P	M	P	M	P[b]	M	P[b]

[a]I=immiscible pair, M=miscible pair, C=pair that forms chemical compound. G=good, F=fair, P=poor. [b]Results are questionable.

■ Selection of bearing materials is largely governed by the anti-seizure properties of the metals in contact. Throughout most of its operating cycle, a journal bearing combination operates under hydrodynamic lubrication, a thin fluid film separating the moving surfaces. Under these conditions the performance of the bearing is virtually independent of the materials used.

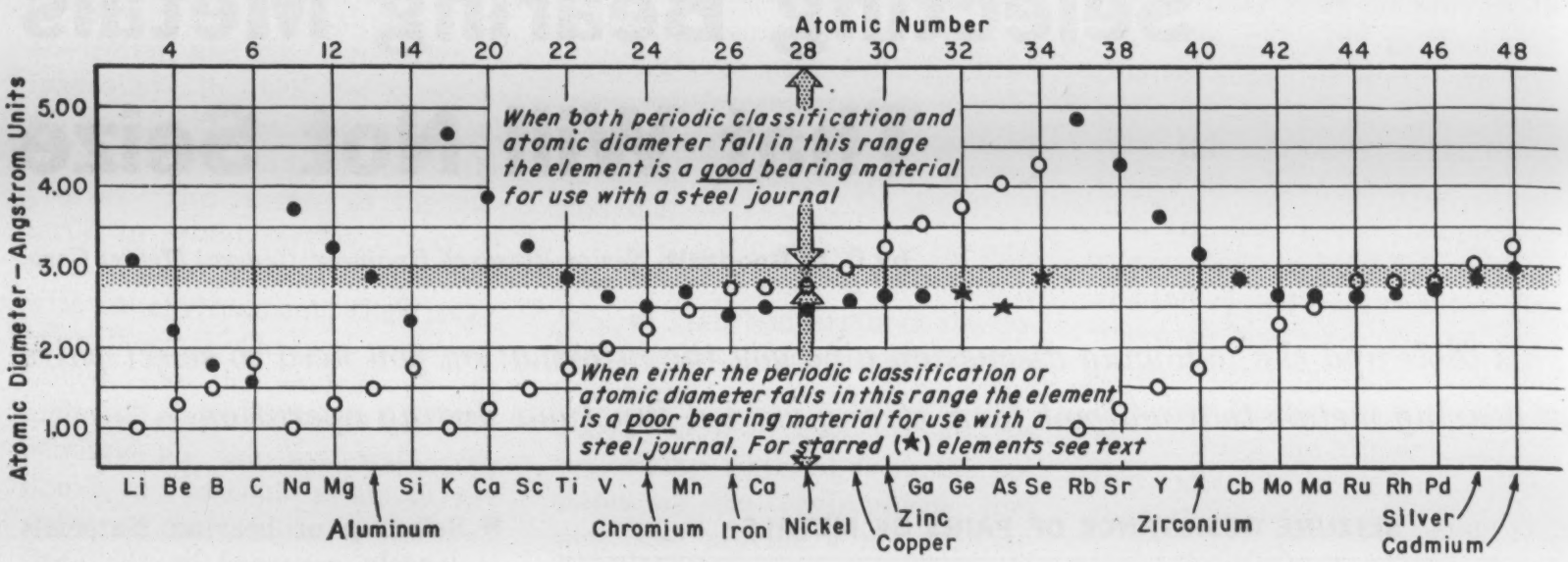
However, when a loaded journal starts or stops the bearing operates under boundary (insufficient) lubrication, involving direct contact and sliding between the journal and the bearing. Seizure can be prevented only by selecting materials that are compatible.

Anti-seizure properties of pure metals

A slider bearing test machine has been used to measure the seizure resistance of some 40 pure metals with journal metals of 1045 steel, copper, silver and aluminum. The load at which failure takes place indicates the relative (not absolute) resistance to seizure. Good bearing metals are able to support a load of 1200 lb (the limit of the machine) without failure, whereas poor bearing metals seize and gall under a load of about 100 lb. With the exception of a few contradictory cases, all of the seizure data given in this article is in direct agreement with the bearing metal theory described on the next page.

Immiscible metals—The bear-

Based on a paper presented before the ASME Design Engineering Conference, Chicago, Apr '58.



Bearing Metal Theory: Key to Determining Seizure Resistance

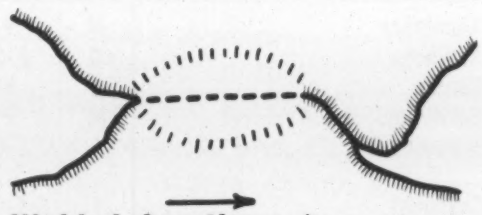
High spots produce welding

The explanation of how metals behave in bearing contact is based on the theory that surfaces in contact touch only at the tips of surface irregularities or asperities. These asperities (see photo) are present on even the smoothest surface and undergo rapid plastic deformation during sliding. During sliding, protective surface films, such as oxides, water and lubricants, are removed from the high spots which then form small welded junctions at the instant that bare metal meets bare metal.

Weld strength determines whether bearing will seize

The relative strengths of these welded junctions determine whether a bearing will seize during the time that it operates with boundary lubrication. If the junctions become stronger than the weaker of the base metals, the metals will tend to wipe and smear and pieces will be removed. On the other hand, if the junctions remain weaker than either of the base metals, they will shear at their interfaces and will not cause any significant damage in depth. (Metallic friction is thought to be caused largely by the making and breaking of welded junctions.)

The strength of welded junctions formed is largely determined by the adhesive strength of the two metals and the amount of metal in the junction. A good bearing design must utilize a pair of materials that tend to form relatively weak welded junctions during bare metal contact.



Welded junctions *form at contacting asperities of sliding surfaces where bare metal meets bare metal.*

Miscible metals form strong welds, poor bearings

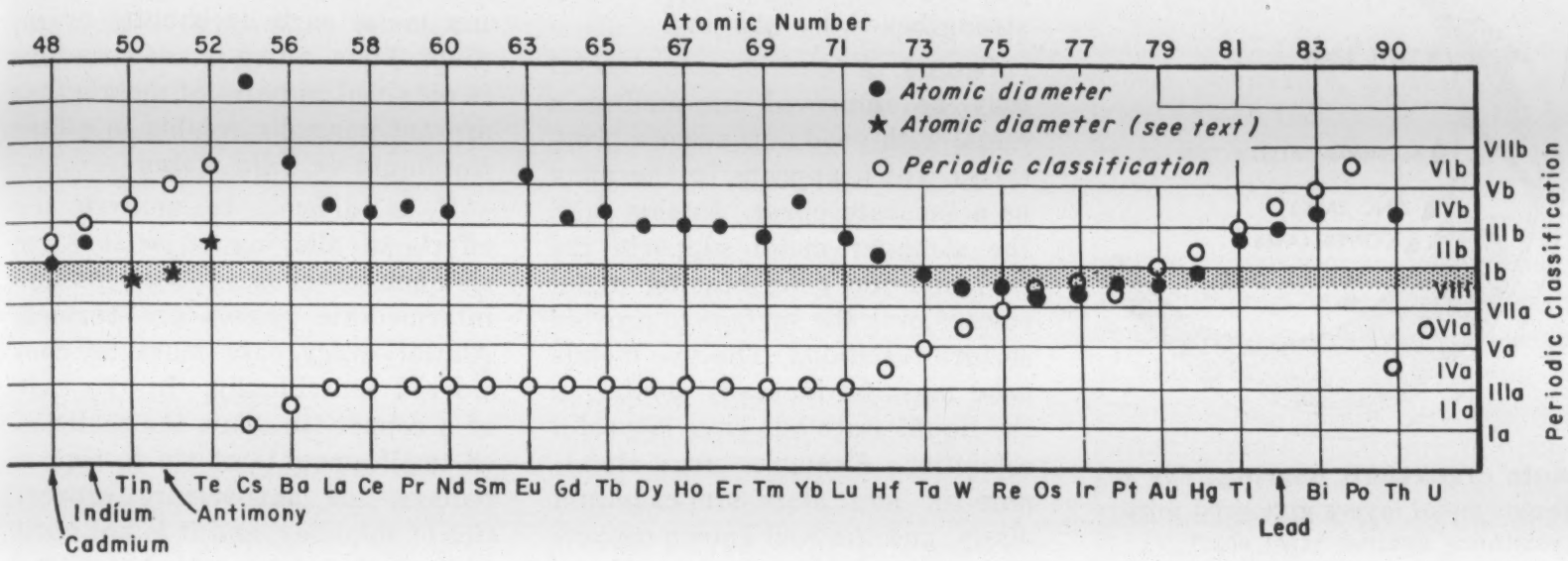
Metals that tend to alloy or exhibit mutual solubility form strong welded joints and make poor mating metal theory states that pairs of metals that are immiscible and do not alloy will not tend to form welded junctions or seize during sliding. All of the metals listed in the table on p 105 with good anti-seizure properties against steel and aluminum are metals that are immiscible (i.e., form comparatively weak covalent bonds) and that fall into "b" subgroups of the periodic table.

Even when a hard metal is run against softer metals such as copper and silver, when a pair of metals is immiscible, any damage produced by the harder metal is comparatively superficial. There is no strengthening of the bond between the metals as is liable to occur when the metals are miscible.

However, as shown in the table on p 105, not all immiscible pairs of metals necessarily have good anti-seizure properties. Note that the immiscible metals that perform poorly with steel are all alkali metals. These metals do not meet the additional compatability requirement of having a bond type different from the journal metal. Similar bond types tend to promote seizure; dissimilar bond types resist seizure.

Metals that form compounds—Except for selenium-aluminum, all of the metal combinations that form definite chemical compounds exhibit good or fair anti-seizure properties. Compounds formed at the point of metal-to-metal contact generally weaken the shear strength of welded joints and consequently minimize any damage in depth.

Miscible metals—The bearing metal theory suggests that miscible pairs of metals have poor resistance to seizure—a hypothesis borne out by the fact that the large majority of miscible metal combinations listed in the table fail at low loads. There are, however, a small number of exceptions. The combination of copper and steel has fair resistance to seizure. A possible explanation of



ing materials for journals and bearings. In such cases, microscopic diffusion of one metal into the other at the sliding interfaces generally causes an increase in the strength and hardness of the welded junctions. Thus, a bearing metal should be used that does not alloy with the base metal of the journal.

How to estimate compatibility from the chart

The elements in the periodic table can be arranged so that there is a transition from metallic to nonmetallic properties. Such an arrangement has been made in the accompanying chart; there is a transition from metallic to nonmetallic properties as the periodic classification is read from bottom to top. The *a* subgroups from Ia to VIIa and the transition metals in group VIII are the "true" metals and are characterized by strong metallic bonds between atoms. With the exception of the Ib elements, the remaining elements are progressively nonmetallic in nature and are characterized by an increasing amount of covalent bonding.

The bearing properties of some 80 pure metals against steel can be estimated from this chart. Essentially, the chart indicates if a bearing material will alloy with a steel journal and if it will form weak or strong welded junctions. Weak junctions, of course, are desired.

The dark band across the center of the chart indicates the limit of the range of materials with atomic diameters 15% greater than iron. Metals above the band have a restricted solubility with iron and make good bearing materials since they are not liable to form welded junctions. Metals below the band have good solubility with iron and do not generally make good bearing materials since they have a tendency to form strong welded junctions.

The position of the dark band is based upon the rule (see *Hume-Rothery*) that alloys can be formed only if the metals are of similar atomic size. If the atoms differ by more than 15% in size, then the lattice distortion of the two metals becomes so great as to restrict alloying and, consequently, the formation of welded junctures.

Certain metals, denoted by a star, react with iron to form definite chemical compounds and their atomic diameter is not a good guide to their alloying ability. These metals form relatively weak welded junctures at the bearing-journal interface and thus provide good anti-seizing properties.

---

this deviation from theory is that although iron exhibits some solubility in copper, the materials may be immiscible in certain ranges of their composition. No explanation can be given for the fact that pairs of miscible metals such as aluminum-zinc and copper-antimony have fair seizure resistance.

Anti-seizure properties of alloys

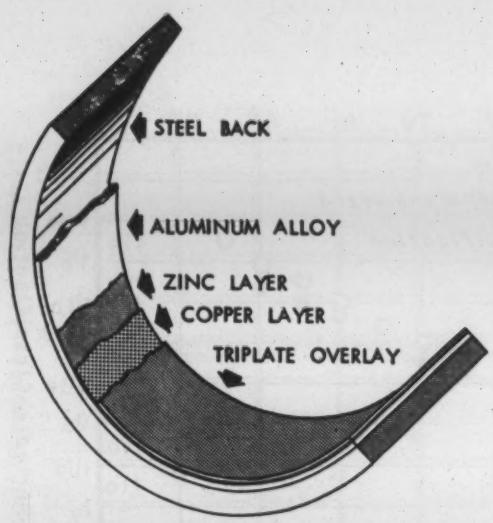
Although resistance to seizure is the most important single requirement of a bearing material other requirements must be satisfied in practice. In general, these requirements cannot be satisfied by pure metals except possibly silver and, to a lesser extent, tin, lead and cadmium. Silver has good seizure resistance against steel, good fatigue resistance, and sufficient hardness and strength. However, it is only fairly tolerant to dirt, and it is sensitive to corrosion by active sulfur. In order to meet a wide range of requirements a bearing must usually be made of a combination of different materials, each of which serves a special function.

Two general rules can be made about the anti-seizure properties of alloys:

1. The seizure resistance of a *good* bearing metal cannot be improved by adding additional alloying agents. A bearing metal or alloy resists seizure with a journal metal by virtue of its immiscibility and difference in bond type. Once this has been established no improvement is obtained by alloying. In fact, alloying a bearing with a metal that is also soluble with the journal frequently reduces the seizure resistance of good bearing metals. The presence of zinc in a babbitt bearing, for example, increases its likelihood of failure.

2. Metals with *poor* anti-seizure properties can often be improved by alloying. Improvement by alloying takes place in two ways:

First, alloying a pure metal generally increases its hardness and strength. Thus, the metal in



Auto crankshaft bearing: five different metal layers give good seizure resistance against steel shaft.

the region of the welded junctions has greater strength and is more resistant to seizure. This effect is particularly noticeable with iron and other transition metals which are quite soft and extremely sensitive to seizure when pure, yet can be readily hardened and strengthened by alloying.

Second, a poor bearing metal may be improved by adding a metal with good anti-seizure properties which appears in the alloy as a separate phase. In this case, the stronger metal supports the load and the good bearing metal smears over the surface to provide seizure resistance. The two metals used must be mutually soluble in the liquid state but have low solid solubility. Examples are: aluminum-tin and aluminum-cadmium alloys, and the well known copper-lead mixture.

The principle of having a strong matrix to support the load and a good bearing metal in segregated areas is utilized in sintered and in gridded bearings. In gridded bearings, the surface of the harder metal is knurled or etched to produce small holes which are filled with a soft bearing metal such as babbitt or indium. Thus, a two-phase structure is obtained in pairs of metals that are not normally soluble in either the liquid or solid states.

It is difficult to analyze the effects of alloying on seizure resistance where solid solutions and intermediate phases are formed. Almost every case must be considered individually. In the case of a copper-tin alloy, the addition of small amounts of tin to copper reduces the anti-seizure properties of the alloy, and it is not until 60% tin has been added that the seizure properties of the alloy show any improvement.

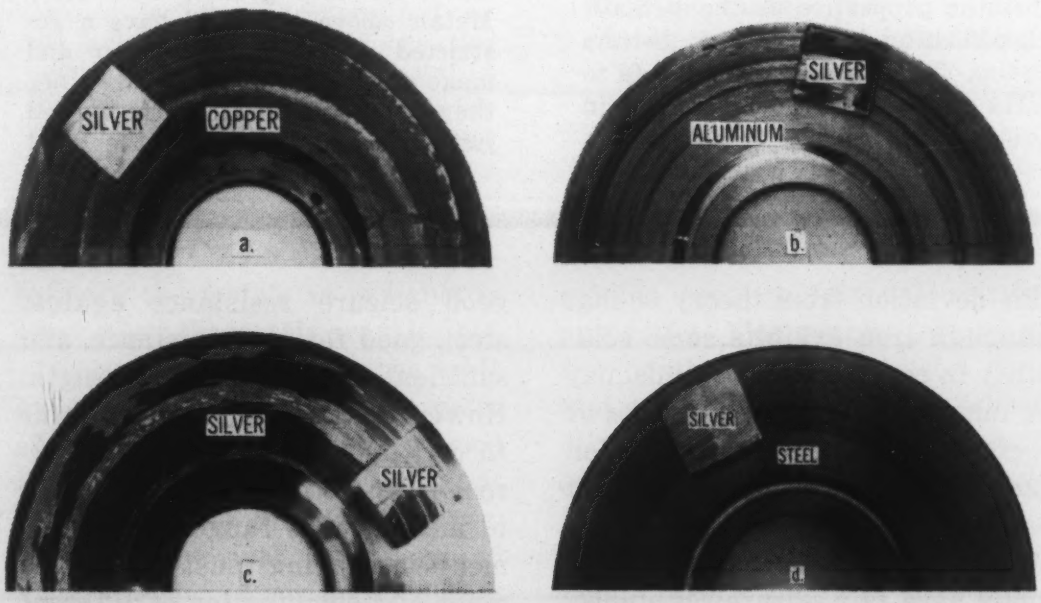
Other selection factors for bearing materials

Once a group of bearing materials with good seizure resistance has been selected, the final

Test Results Support Bearing Metal Theory

***Zirconium** is soluble with iron and should not be used against a steel journal. Note that blobs of zirconium are welded to the 1045 steel disk and both surfaces are extensively damaged after testing.*

***Antimony** tends to form weak metallic compounds with iron. For this reason it makes a good bearing material and performs satisfactorily against 1045 steel up to the load limit of the testing machine.*



***Silver** is soluble with copper and aluminum, and damage is severe when silver is run against either of these metals (a and b). Silver against silver also produces quick and extensive damage (c). However, silver and iron are immiscible metals and do not seize or cause any damage when run under high loads (d).*

choice can depend on a number of other requirements whose relative importance depends on the application. The most important of these requirements are:

1. Required form, i.e., machined part, casting, metal compact, electroplated coating, or a bearing bonded or clad to a backing.
2. Resistance to corrosion, fatigue, dirt and heat.
3. Rigidity, dimensional stability and alignment.
4. Quantity required.

An excellent example of the factors that go into selecting bearing materials is provided by the modern automobile crankshaft bearing. The bearing shown in the accompanying figure must resist seizure under heavy loads during boundary lubrication, as well as fatigue from dynamic loads. It must also resist corrosion from crankshaft contaminants and be able to tolerate dirt in lubricants. Also, dimensional stability and uniformity must be satisfied even though the bearing is made by the millions. How do materials and design satisfy these needs?

First of all, a bearing metal with good seizure resistance must be used against the steel crankshaft. This metal must also be soft and have the ability to embed dirt particles. Lead is ideally suited for this job because of its softness, extreme insolubility in iron, and resistance to seizure with steel. However, lead is subject to corrosion by oxidized oil; consequently it is usually alloyed with a small amount of tin to inhibit corrosion. In addition 1% of copper is added to increase hardness. The resulting alloy is called babbitt or triplate.

This babbitt is still quite soft and thus has poor fatigue resistance. (A general rule for bearings of this type is that fatigue resistance is proportional to hardness.) Therefore, a thin, ½-mil layer of the babbitt is backed up by a harder bearing metal with good resistance to seizure and fatigue—in this case a 10-mil layer of aluminum alloy over steel. The aluminum is first coated with about a millionth of an inch each of zinc and copper to provide a firm foundation for the electroplated triplate. The zinc and copper layers are so thin that they have no adverse effect on the other bearing metals.

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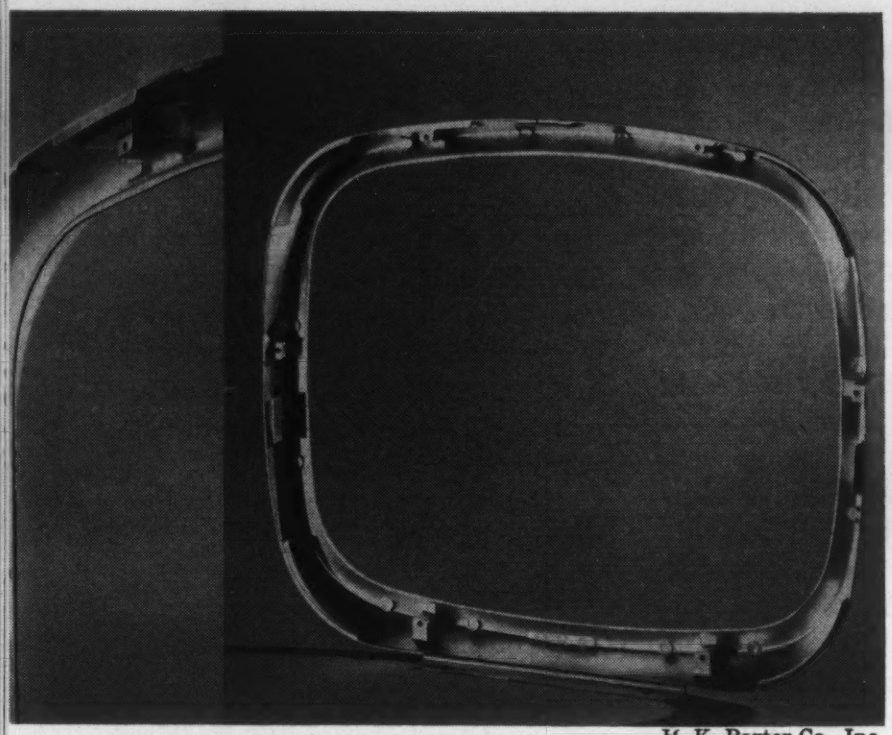
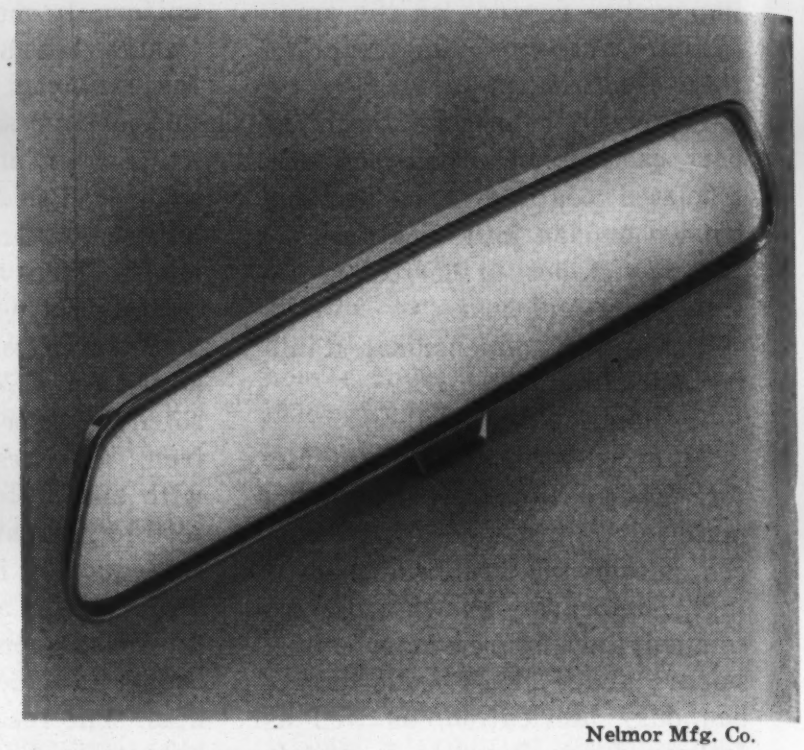
Indium, *though normally a very good bearing material to use against a steel journal, is soluble with copper and silver and seizes when run against these materials (*a *and* b*). Conversely, indium and aluminum are immiscible and can be run against each other at high loads without seizing. As shown in* c*, the soft indium extruded under load and discolored the aluminum disk, but there is no evidence of metal welding.*

Iron *is a hard bearing material. When it is run against the softer copper and aluminum disks (*a *and* b*), these materials are damaged as a result of mutual solubility and the formation of strong welded junctions. In contrast, though failure occurs on the silver disk (*c*), damage is minimized because of extreme immiscibility of the iron and the silver. Despite the high load stresses at the contact area, only a thin, small layer of silver is welded to the iron.*



H. K. Porter Co., Inc.

Portable TV screen frame *is vacuum die cast from zinc. This part was originally to be aluminum, but ability to produce thin walls makes possible a zinc die casting weighing no more than the aluminum part.*



Nelmor Mfg. Co.

Inside rear view mirror *has been converted from a stamping to a vacuum die casting. Conversion to zinc die casting was possible because of ability of vacuum process to cast thin walls.*

Vacuum Die Castings of Zinc

have | *Low porosity*
Good surface
Thin walls

by John L. Everhart, *Technical Editor, Materials in Design Engineering*

■ Use of a partial vacuum in the die casting process makes possible the production of parts with exceptionally thin sections that could not be produced economically, if at all, by regular procedures. Properties, finish and uniformity are all improved, and standard die casting machines can be modified to use the process and existing dies need not be changed.

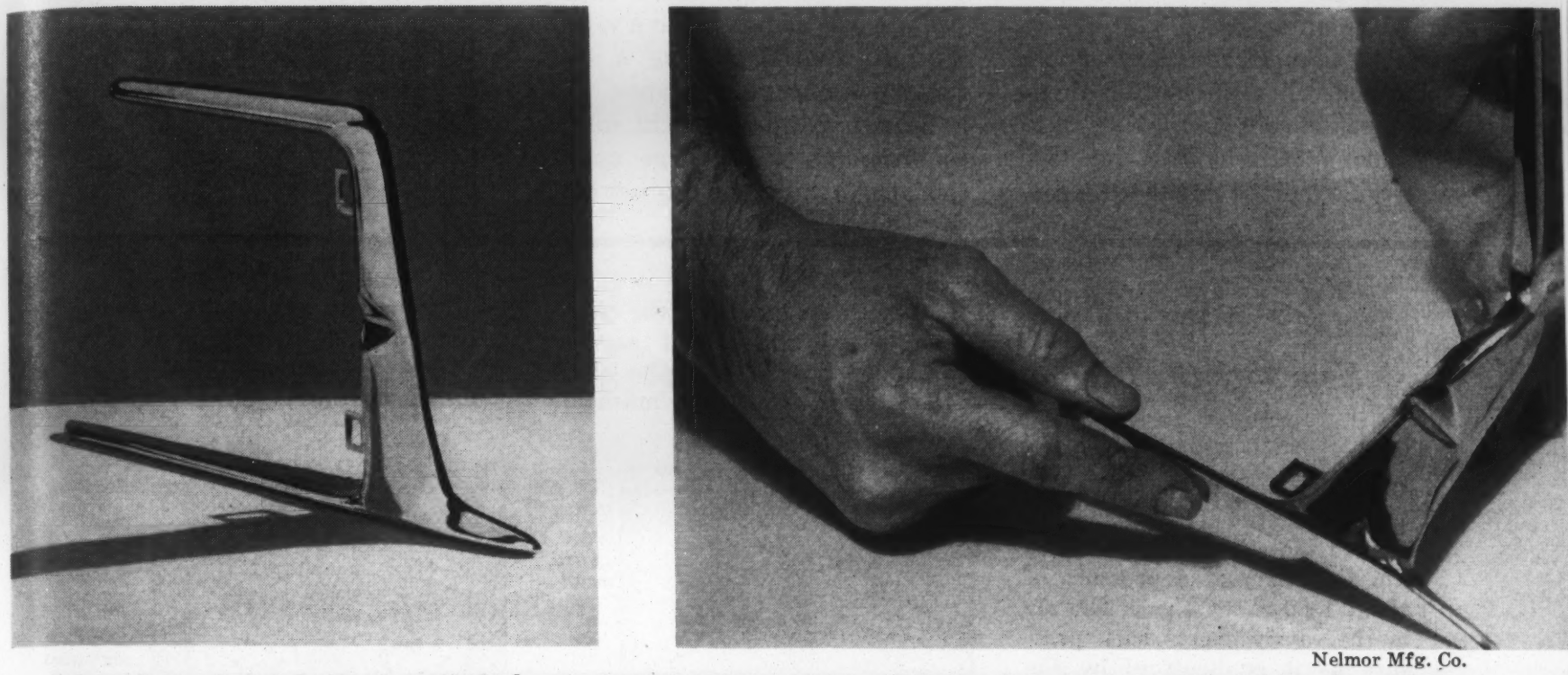
The process is being applied commercially to zinc die casting and is in the development stage on aluminum. No indication of its use in the production of magnesium die castings has been found.

Major advantages

The major attributes of vacuum die castings of interest to the designer are:

1. *Low porosity.* Vacuum die casting greatly reduces entrapment of air which is ordinarily converted into tiny voids under the skin of the casting. Thus, rejects caused by uncovering pores during machining or buffing are greatly reduced. In addition, blistering upon heating is reduced, making it possible to use higher baking temperatures after painting.

In practical operation it has been found that vacuum die castings contain only minor amounts of minute porosity, and mechanical properties are improved. For example, tensile tests were run on samples cut from castings produced in the same die by conventional and vacuum die casting. The average tensile strength of the conventional castings was 38,000 psi, that of the vacuum castings 43,000 psi. Rockwell hardness of the standard castings was B33, that of the vacuum castings B40. Because of increased soundness, vacuum die castings can



Nelmor Mfg. Co.

***Trim piece** of zinc, having a wall thickness of 0.025-0.030 in. and excellent surface finish, is 20% lighter than similar piece made of buffed stainless steel. Right-hand photo shows ductility of this vacuum die casting.*

meet higher pressure test requirements.

2. *Good finish.* The surface finish obtained on vacuum die castings is excellent. Costs of finishing are greatly reduced. In many cases, little buffing is required to prepare the surface for plating or painting.

3. *Thin walls.* Wall thicknesses can be decreased by 25 to 50%. Minimum wall thickness of conventional zinc die castings is ordinarily 0.060 in., although some parts are produced with wall thicknesses of 0.030 to 0.040 in. In the vacuum process, wall thicknesses of 0.030 in. are common, and parts with wall thicknesses down to 0.018 in. have been made. Long thin sections that could not previously be produced economically are now possible. In addition, castings having heavy and light wall sections, or bosses and ribs, can be produced without the usual problems of porosity and cold-shuts. Sink marks due to bosses on light sections are minimized.

As a result, zinc die castings are competing successfully with stampings and have replaced aluminum die castings in some applications.

Production and costs

In general, die casters are reluctant to discuss relative costs of conventional versus vacuum die castings. However, there are some indications obtainable from production rates.

Although it would appear at first thought that additional time would be required to produce a vacuum die casting, such is not the case. It requires only a fraction of a second to reach the partial vacuum required. There is practically no air film to prevent contact of the liquid metal with the die wall; consequently, chilling occurs more rapidly than in the conventional machine. Because there is insufficient entrapped air to cause blistering of a hot casting, the die can be opened more rapidly, thus permitting the casting to cool in air. As a result, parts can be produced at rates comparable with, or higher than, those obtained in conventional die casting. One producer reports that he obtains an overall increase of 10 to 20% in production rate.

Whether the vacuum process is helpful for the general run of parts is a matter of some disagreement. Some producers say that there is no advantage; others say that dies can be put into production with less cut-and-try gating and that heavier castings can be made at greater speeds than possible with the conventional method.

Applications

Automotive uses in addition to those shown on pp 110 and 111 include tail lights, hand spotlight frames, dashboard and radio bezels, mirror frames, license plate frames and trim. In converting a tail light from conventional to vacuum casting, rejects were reduced from 30% to 5% at

How Much 'Vacuum'

The term *vacuum* is used rather loosely in industry, implying in some cases pressures of a few millimeters and in others pressures of a fraction of an atmosphere. In the die casting industry, pressures of ½ to ¼ atm are used; a better term for the process might have been *reduced back pressure die casting*. However, the industry has adopted *vacuum die casting*, and this term will be used here.

a production rate of 180 shots per hr, and the improved surface reduced finishing costs.

Other uses include large appliance parts such as washer rings, clock escutcheons and loving cups. An oblong coin bank 3 in. deep that could not be produced satisfactorily because of poor surface condition resulting from entrapped air was converted to a vaccum zinc die casting having a satisfactory surface appearance.

Because of the excellent surface condition obtained, large quantities of plumbing and cabinet hardware are being produced as vacuum die castings.

Acknowledgments

The assistance of the following organizations in developing this article is gratefully acknowledged:

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Reed-Prentice Corp.

Why Evacuate the Die?

Conventional process

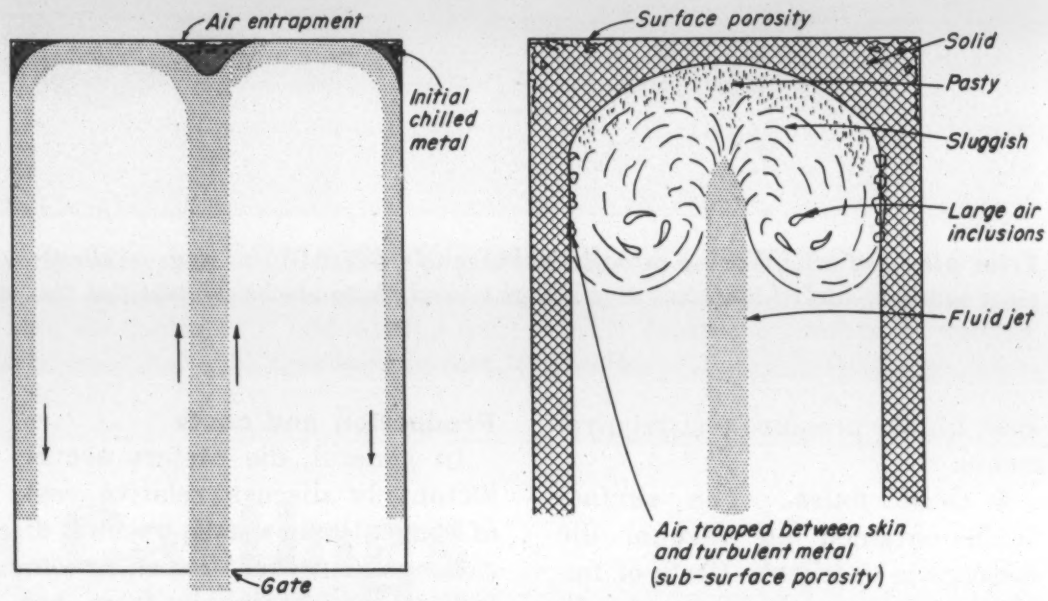
In conventional die casting, a shot of the alloy is injected into the die cavity at a pressure of about 1500 to 2000 psi. The air in the cavity exerts back pressure as it is displaced by the liquid metal. Vents in the tools are designed to permit escape of this air and thus limit the back pressure. If the vents work perfectly, there is no back pressure and the influx velocity depends entirely on the difference in pressure between that exerted by the plunger on the liquid metal and the atmospheric pressure on the surface of the metal in the die cavity.

Although such a reduction in back pressure might be achieved in a new set of tools, it is only partially successful and eventually some of the vents become plugged. As a result the back pressure increases, the pressure differential is reduced, the flow of metal is retarded, and some air is trapped in the casting, forming voids.

Relatively sound castings can be obtained by using heavy gating, high metal temperatures and sufficiently large overflows to permit escape of some of the air. However, thin sections, where the metal flows less freely and solidifies more quickly, are difficult to fill without voids and cold-shuts unless vents keep the back pressure from increasing.

Vacuum process

Reducing the pressure in the die to ¼ atm does not greatly increase the injection velocity at the start of the operation, but does delay the rise in back pressure until the die is almost filled. This delay increases the possibility of filling thin sections completely. In addition, there is only one-fourth as much air in the cavity as there is in conventional die casting, thus reducing the possibility of void formation by four times.

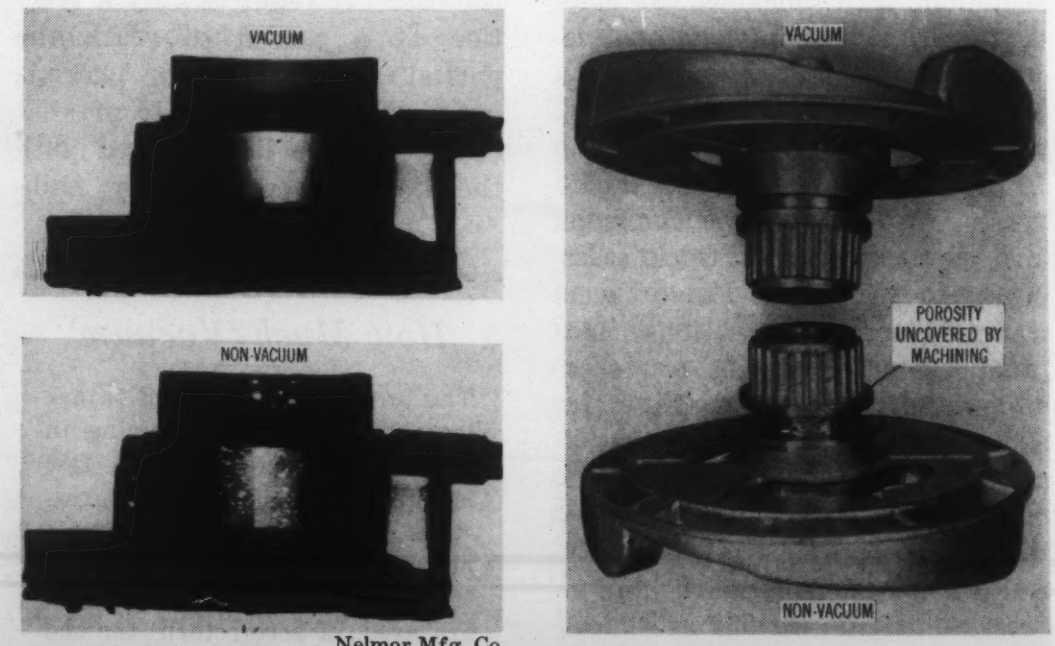


Nelmor Mfg. Co.

How die usually fills

First, *air is trapped by the frozen skin, producing surface defects.*

Second, *trapped air between skin and turbulent metal, results in defects.*



Nelmor Mfg. Co.

Porosity is one major problem

Radiographs *show increase in density in vacuum die casting.*

Scrap is reduced *when machining fails to uncover any porosity.*

Guide to Materials Standards and Specifications

Part 4—Plastics and Rubber

by S. P. Kaidanovsky,
Consulting Engineer

■ Standards and specifications on plastics and rubber are prepared or issued by most of the governmental agencies and national organizations, such as the Federal Supply Service, Dept. of Defense, Commodity Standards Div. of the U.S. Dept. of Commerce, American Society for Testing Materials, Society of Automotive Engineers and American Standards Assn. Their standardization activities were covered in Part 1 of this series. In addition, the following trade and technical societies concerned with plastics and rubber prepare standards or assist standards agencies: the Society of The Plastics Industry, Society of Plastics Engineers, Rubber Manufacturers Assn., the National Electrical Manufacturers Assn., and the Manufacturing Chemists' Assn.

The standards and specifications on plastics and rubber issued by various organizations are summarized in accompanying table.

Society of the Plastics Industry

The Society of the Plastics Industry (SPI) is a trade and technical society concerned with research, quality standards and other activities of interest to the plastics industry. To encourage the manufacture of quality products, various divisions of the society have fostered the development of voluntary industry standards. Most of the plastics industry standards, known as Commercial Standards (see Part 1, Mar '58), have been developed and adopted according to the standards procedure of the Commodity Standards Div., U. S. Dept. of Commerce.

The technical and standardization activities of the society are centered in the engineering and technical committees and subcommittees. These committees compiled the *Plastics Engineering Handbook of the SPI*. This handbook contains, among other subjects of interest to the plastics industry, standards for plastics and plastics products, and a classification system for rigid molding materials.

The SPI designations for rigid molding materials consist of a letter prefix identifying the type of plastic, a grade number based on three basic properties, and a letter suffix indicating special properties or categories.

The letter or letters identifying the type of plastic are as follows:

Thermoplastic

CA —Cellulose acetate
CAB—Cellulose acetate butyrate
EC —Ethyl cellulose
HH —Halogenated hydrocarbons
MM —Methyl methacrylate
PA —Polyamides
PS —Polystyrene and/or modified polystyrene
VC —Vinylidene chloride
VCA—Vinylidene chloride acetate

Thermosetting

EA —Ester alkyd
MF —Melamine formaldehyde
PF —Phenol formaldehyde
UF —Urea formaldehyde
S —Silicone

The grade number is constructed as follows: the first two digits represent the heat distortion temperature; the third and fourth digits represent the impact strength; and the remaining digits represent the tensile strength. The suffixes that identify special properties or categories are as follows: *M*—mechanical, *E*—electrical, *O*—optical, *T*—thermal, *C*—chemical and *A*—aging. Individual properties within any category are identified by a lower case letter following the capital letter.

For example, in the SPI grade *CA11143Eg*, *CA* identifies a cellulose acetate molding compound. The first two digits, *11*, represent its heat distortion temperature at 264 psi fiber stress (110 F with the last digit dropped); the third and fourth digits, *14*, represent the impact strength (1.4 ft-lb with the decimal point omitted); the fifth digit, *3*, represents its tensile strength in thousands of psi (3000 with three zeros dropped). The *E* identifies the plastic as having one or more spe-

This is the fourth in a series of six articles. Subsequent articles will deal with organizations and standards on other nonmetallics and finishes.

SUMMARY LIST OF STANDARDS AND SPECIFICATIONS FOR PLASTICS AND ELASTOMERS

Organization	Type of Document	Document Identification[a]	Material, Forms, Uses
ACRYLICS			
ASTM	Spec	DXXX	Molding and extrusion compounds; cast sheet, rod and tube; other cast shapes; machined cast blanks
SAE	Mtl Spec	AMS 3626	Molding and extrusion compounds. Aeronautical uses
Federal	Spec	L-P-XXX	Cast sheet, rod and tube
Military	Spec	MIL-P-XXX	Molding compounds; molded parts; extrusions; cast sheet, rod and tube
CELLULOSICS			
Comm Dept. & SPI	Comm Std	CS 206	Cellulose acetate butyrate. Pipe
ASTM	Spec	DXXX	Cellulose acetate. Cast film, sheet; rigid sheets; molding and extrusion compounds. General purpose or aircraft uses
ASTM	Spec	D707	Cellulose acetate butyrate. Molding and extrusion compounds
ASTM	Spec	D701	Cellulose nitrate (pyroxylin). Sheet, rod, tube
ASTM	Spec	D787	Ethyl cellulose. Molding and extrusion compounds
SAE	Mtl Spec	AMS 3622	Cellulose acetate. Molding and extrusion compounds. Aeronautical uses
SAE	Mtl Spec	AMS 3624	Cellulose acetate butyrate. Molding and extrusion compounds. Aeronautical uses
Federal	Spec	L-P-344	Cellulose acetate. Molding compounds
Federal	Spec	L-P-349	Cellulose acetate butyrate. Molded and extruded parts
Federal	Spec	L-P-365	Cellulose nitrate (pyroxylin). Sheet, rod, tube
Military	Spec	MIL-P-XXX	Cellulose acetate. Sheet, film, molding compounds; molded parts
Military	Spec	MIL-P-XXX	Cellulose acetate butyrate. Molding compounds; molded parts
Military	Spec	MIL-P-XXX	Ethyl cellulose. Molding compounds; molded and extruded shapes. Electronic and electrical equipment
ELASTOMERS			
ASTM	Rec Prac	D1207[b]	Elastomers. Automotive uses
ASTM	Spec	D735[c]	Vulcanized elastomers. Automotive uses
ASTM	Spec	D1056[d]	Sponge and expanded cellular rubbers. Sheet, strip; molded or special shapes. Automotive uses
ASTM	Spec	D1055[e]	Latex foam rubbers. Sheet, strip; molded or specific shapes. Automotive uses
ASTM	Spec	D1277[f]	Rubber-like non-rigid thermoplastics. Automotive and aeronautical uses
SAE	Mtl Spec	AMS 32XX	Synthetic rubber. Aircraft uses
SAE	Mtl Spec	AMS 33XX	Silicone rubber. Aircraft uses
Military	Spec	MIL-R-XXX	Synthetic rubber. Sheet, strip; molded and extruded shapes; gaskets
Military	Spec	MIL-R-7362	Synthetic rubber (oil resistant). Sheet, strip; molded and extruded shapes
Military	Spec	MIL-R-XXX	Cellular rubber. Sheet, molded shapes. Aircraft uses
Military	Spec	MIL-R-5847	Silicone rubber. Aeronautical uses
RMA	Spec	—	Latex foam. Sheet, strip; molded or special shapes
FLUOROCARBONS			
ASTM	Spec	D1430	Polychlorotrifluoroethylene (plasticized). Molding and extrusion compounds

[a] *XXX* in the document identification indicates that more than one standard has been developed on the material. Revisions, amendments and year are not indicated (the latest issue is supplied when an order is placed).
[b] SAE Rec Prac 16R. [c] SAE Std 10R. [d] SAE Rec Prac 18R. [e] SAE Rec Prac 17R. [f] SAE Rec Prac 130R.

cial electrical properties, and *g* indicates dielectric strength of at least 250 v per mil for a short time.

Society of Plastics Engineers

The Society of Plastics Engineers (SPE) is a scientific and educational organization devoted to the development and dissemination of technical information in the fields of research, design, development, production and utilization of plastics materials.

Technical committees of the society, called Professional Activities Groups, serve in an advisory capacity the membership of the society and anyone in the industry requesting technical information.

The society has done no work directly on standardization. It has pooled its interest and efforts with those of the American Society for Testing Materials. Many members of ASTM Committee D-20 on Plastics are also members of the Society of Plastics Engineers.

Rubber Manufacturers Assn.

The technical committees of the Rubber Manufacturers Assn. (RMA), composed entirely of industry personnel operating on a voluntary basis, do not write minimum specifications except in a few minor instances. They do, however, review proposed specifications for many specification-writing agencies, such as all branches of the Federal Government and the Society of Automotive Engineers. In this capacity the RMA's interest is to be sure that the requirements of the specification are within the competency of the manufacturing industry.

The association has published a *Glossary of Terms Used by the Mechanical Rubber Goods Industry*, a *Buyers' Specification for Latex Foam*, and *Compression Range Guide* for latex foam. It also has developed an RMA designation system to indicate degree of firmness of latex foam; the designations are listed below:

Cored Stock

½	2	3½	5	8
1	2½	4	6	
1½	3	4½	7	

Slab or Uncored Stock	
Extra Soft	X Firm
Soft	XX Firm
Medium	XXX Firm
Firm	XXXX Firm

The above RMA designations differ from the ASTM designations of firmness of latex foam described later.

National Electrical Manufacturers Assn.

One of the most important activities of the National Electrical Manufacturers Assn. is standardization, which is carried on by a number of technical committees. The association cooperates with the Federal Government, the American Standards Assn. and trade and technical associations and societies by furnishing information and recommendations for use in the preparation of standards and specifications.

NEMA issues a number of standards covering the manufacture, performance and test of electrical materials, apparatus, devices and supplies. It has also issued a series of standards for laminated plastics products (LP).

Manufacturing Chemists' Assn.

The Manufacturing Chemists' Assn. (MCA) represents more than 90% of the chemical production capacity in the United States. Many of its members are engaged in various phases of plastics production—from raw materials to end products. The association has a Plastics Committee; it also sponsors a project on fundamental properties of plastics at Massachusetts Institute of Technology.

The MCA does not issue its own standards. However, it advises and assists the American Standards Assn., the American Society for Testing Materials and other standardization groups. The association has published *Technical Data on Plastics*. The purpose of this book is to acquaint its user with the properties which characterize the various commercially available plastics.

ASTM Designations

Elastomers—The American Society for Testing Materials has

SUMMARY LIST (continued) OF STANDARDS AND SPECIFICATIONS FOR PLASTICS AND ELASTOMERS

Organization	Type of Document	Document Identification[a]	Material, Forms, Uses
FLUOROCARBONS—continued			
ASTM	Spec	D1457	Polytetrafluoroethylene. Molding and extrusion compounds
SAE	Mtl Spec	AMS XXX	Polychlorotrifluoroethylene. Plasticized film, unplasticized tube. Aeronautical uses
SAE	Mtl Spec	AMS 3652	Polytetrafluoroethylene. Film. Aeronautical uses
Military	Spec	MIL-P-XXX	Polytetrafluoroethylene. Molding and extrusion compounds; sheet, rod, tubing
LAMINATES			
ASTM	Spec	D710[g]	Vulcanized fibre. Sheet, round rod and tube. Electrical insulation
ASTM	Spec	D709[h]	Thermosetting. Sheet; round and rectangular tube
NEMA	Std	45-107[i]	Fabricating. Electrical uses
NEMA	Std	LP-1	Thermosetting. Electrical uses
NEMA	Std	VU1[j]	Vulcanized fibre. Electrical uses
Federal	Spec	L-L-31	Thermosetting. Sheet, rod, tube
Military	Spec	MIL-P-18177	Epoxy-glass cloth. Sheet. Electrical uses
Military	Spec	MIL-P-15037	Melamine-glass cloth. Sheet
Military	Spec	MIL-P-XXX	Phenolic. Paper-base, cotton fabric-base, nylon fabric-base. Sheet, rod, tube
Military	Spec	MIL-P-997	Silicone-glass cloth. Sheet. Electrical uses
MELAMINES			
ASTM	Spec	D704	Molding compounds
SAE	Mtl Spec	AMS 3640	Mineral-filled. Molding compounds. Aeronautica uses
Federal	Spec	L-M-181	Molding compounds
Military	Spec	MIL-M-14	Molding compounds
PHENOLICS			
ASTM	Spec	D700	Hot molding compounds
SAE	Mtl Spec	AMS 3615	Tube. Aeronautical uses
SAE	Mtl Spec	AMS 3607	Cotton fabric-reinforced. Sheet, plate. Aeronautical uses
SAE	Mtl Spec	AMS 3641	Macerated fabric-filled. Molding compounds Aeronautical uses
Federal	Spec	L-P-310	Molding compounds
Federal	Spec	TT-R-271	General uses
Military	Spec	MIL-P-13436	Fiber filled (uncured). Sheet
Military	Spec	MIL-P-XXX	Molding compounds; molded parts, sheet, rod
Military	Spec	MIL-R-XXX	General uses
Military	Spec	MIL-P-5431	Graphited. Sheet, rods, tubes, shapes. Aeronautical uses
POLYAMIDES (nylon)			
ASTM	Spec	D789	Molding and extrusion compounds
Military	Spec	MIL-P-17091	Molded parts, rods, flats
POLYESTERS			
ASTM	Spec	D1201	Molding compounds
Military	Spec	MIL-M-14	Molding compounds
Military	Spec	MIL-P-8257	Molded transparent sheet
Military	Spec	MIL-P-8013	Low pressure laminate (glass fabric)
Military	Spec	MIL-R-7575	Low pressure laminate

[g] American Std. ASA C59.29.
[h] American Std. ASA C59.16.
[i] American Std. ASA C59.17.
[j] American Std. ASA C59.20.

SUMMARY LIST (concluded) OF STANDARDS AND SPECIFICATIONS FOR PLASTICS AND ELASTOMERS

Organization	Type of Document	Document Identification	Material, Forms, Uses
POLYETHYLENES			
Comm Dept. & SPI	Comm Std	CS 197	Flexible pipe
ASTM	Spec	D1248	Molding and extrusion compounds
Federal	Spec	L-P-590	Molding and extrusion compounds
Military	Spec	MIL-P-3803	Molded and extruded shapes; sheet, tube
POLYSTYRENES			
ASTM	Spec	D703	Molding and extrusion compounds
ASTM	Spec	D1431	Acrylonitrile copolymer. Molding and extrusion compounds
SAE	Mtl Spec	AMS 3620	Molding and extrusion compounds. Aeronautical uses
Federal	Spec	L-P-416	Molding compounds
Military	Spec	MIL-P-XXX	Molding and casting compounds, molded parts
Military	Spec	MIL-P-3796	Glass-filled. Molding compounds, molded parts
Military	Spec	MIL-P-3409	Polydichlorostyrene. Molding compounds
UREAS			
ASTM	Spec	D705	Molding compounds
Federal	Spec	L-U-671	Molding compounds
VINYLS			
Comm Dept. & SPI	Comm Std	CS 192	Vinyl. Film. General uses
Comm Dept. & SPI	Comm Std	CS 201	Vinyl chloride. Rigid sheet
ASTM	Spec	D728	Vinyl chloride-acetate. Rigid molding compounds
ASTM	Spec	DXXX	Vinyl chloride and copolymer. Rigid sheet; non-rigid molding and extrusion compounds; tubing
ASTM	Spec	D729	Vinyl chloride-vinylidene chloride copolymers. Molding compounds
SAE	Mtl Spec	AMS 3630	Vinyl chloride. Flexible extrusion. Aeronautical uses
Federal	Spec	L-P-510	Vinyl chloride (modified). Rigid sheet
Federal	Spec	L-V-XXX	Vinyl chloride and copolymer. Rigid sheet and molding compounds
Federal	Spec	L-P-501	Vinylidene chloride. Molding compounds
Military	Spec	MIL-P-XXX	Vinyl chloride and copolymers. Sheet (thin); rigid molding compounds. Electronic and electrical equipment
Military	Spec	MIL-R-3584	Vinyl chloride. Non-rigid
Military	Spec	MIL-P-3411	Vinylidene chloride. Rigid molding compounds. Electronic communications and allied electrical equipment
OTHER PLASTICS			
ASTM	Spec	D819	Allyl. Cast sheet, rod, tube; other cast shapes; machined cast blanks
Federal	Spec	L-L-31	Silicone. Sheet, tube, rod
Military	Spec	MIL-P-77	Allyl resin. Casting
Military	Spec	MIL-P-3408	Aniline formaldehyde. Molding compounds
Military	Spec	MIL-R-20612	Chlorinated diphenyl
Military	Spec	MIL-R-9300	Epoxy. Low pressure laminates

developed jointly with the Society of Automotive Engineers a system for designating elastomer compounds for automotive uses (ASTM D735-57T and SAE Standard 10R). These compounds are also used by many other manufacturing industries.

The type and class of the elastomers are represented by capital letters as shown below:

Type *R*—Compounds of natural rubber, synthetic rubber and reclaim, alone or in combinations thereof. Non-oil resistant.

Type *S*—Compounds of synthetic rubber or combinations thereof having resistance to swelling. Oil resistant.

- Class *SA*—Very low volume swell.
- Class *SB*—Low volume swell.
- Class *SC*—Medium volume swell.

Type *T*—Compounds of synthetic rubber or rubber-like materials. Resistance to abnormal temperature and/or oils.

- Class *TA*—Maximum resistance to heat and cold.
- Class *TB*—Outstanding resistance to heat and oil.

Each class consists of a number of different grades. These grades are designated by numbers following the prefix letters. When necessary, suffix letters are used after the grade number to indicate additional properties.

Grade numbers consist of three digits. The first indicates the durometer hardness range; e.g., *3* for 30 ± 5. The next two digits indicate the minimum tensile strength; e.g., *05* for 500 psi. Suffix letters are added singly or in combination after the grade number; e.g., E_1 for oil resistance.

Thus, grade $SB625F_1$ designates a compound with good oil resistance, having low volume swell in petroleum-base fluids (*SB*), a durometer hardness of 60 ± 5 (*6*), and an original minimum tensile strength of 2500 psi (*25*). It should pass a low temperature test at –40 F (F_1) and conform to other basic requirements.

The ASTM has also developed jointly with the SAE a system for designating elastomer compounds for use in resilient automotive mountings (ASTM Recommended Practice D1207-55, SAE Recommended Practice 16R).

The dynamic properties of automotive compounds are designated as follows: A prefix letter *C* designates a resilient mounting compound tested in compression.

The prefix letter *S* designates a compound tested in shear. The suffix numbers designate the resilience and effective dynamic modulus of the compound. The first digit indicates the resilience; e.g., *8* for 80%. The next two digits indicate the effective dynamic modulus. For compression modulus, multiply by 100; for shear modulus, multiply by 10.

Thus, for a compound designated *C906-R520-BF$_1$KZ*, *C* represents mounting compound tested in compression, *9* indicates resilience of 90% required, *06* indicates effective dynamic modulus of 600 ± 15%, *R520-BF$_1$KZ* designates the type, class and grade of the rubber compound as explained above. [Thus, the elastomer is non-oil resistant, with a durometer hardness of 50 ± 5, and an original minimum tensile strength of 2000 psi; it should pass a compression set test (*B*), a low temperature test at –40 F and an adhesion test (*K*); and it should meet other special requirements (*Z*).]

The ASTM has also developed jointly with the SAE a system of designating non-rigid rubber-like thermoplastic compounds for automotive and aeronautical uses (ASTM D1277-53T, SAE Recommended Practice 130R), comparable to that for rubber compounds.

Non-rigid thermoplastic rubber-like plastics, alone or in combination, are designated by grade numbers consisting of three digits following the type prefix *NP*. The first digit indicates the durometer "A" hardness range, e.g., *5* for 50 ± 5. The next two digits indicate the minimum tensile strength, *e.g., 10* for 1000 psi. Suffix letters are added singly or in combination after any grade number indicating additional requirements.

Thus, grade *NP-820-C* designates a rubber-like plastic with a durometer "A" hardness of 80 ± 5 and an original minimum tensile strength of 2000 psi which must pass a specified light or weather aging test (*C*).

Latex foam rubbers—The ASTM system for designating grades of latex foam rubbers (ASTM D1055-56T, SAE Recommended Practice 17R) consists of two digits following the type, *R*. The first digit identifies the kind of latex foam rubber: *2* for cored, *3* for uncored. A second digit is used to indicate the degree of firmness (the firmer the grade the higher the number). One or more suffix letters are added after any grade number to indicate additional requirements beyond the basic requirements. Thus, grade *R22F$_1$H* denotes soft, cored latex foam rubber with a load deflection value of 17½ ± 4½ and requiring, in addition to the basic properties, a low temperature test at –40 F (*F$_1$*) and a flexing test (*H*).

Sponge and expanded cellular rubbers—The two types of cellular rubber are designated by the prefix letters *R* for non-oil resistant and *S* for oil resistant. Type *S* rubbers having oil resistance with medium swell are designated *SC*.

Each type of cellular rubber has a number of different grades (ASTM D1056-56T, SAE Recommended Practice 18R). Grades are designated by numbers following the type prefix letters and consist of two digits. The first identifies the kind of cellular rubber: *1* for sponge, *4* for expanded. The second digit indicates the degree of firmness of the cellular rubbers (the firmer the grade the higher the number). Suffix letters are added singly or in combination after any grade number to indicate additional properties beyond basic requirements.

Thus, grade *R11CF* denotes extra-soft sponge rubber having a load deflection value of 3½ ± 1½ psi, having no specific solvent or oil resistant properties, and requiring, in addition to the basic tests, a weather resistance test (*C*) and a low temperature test at –40 F (*F*).

Where to Obtain Standards for Plastics and Rubber

American Society for Testing Materials
1916 Race St., Philadelphia 3.
ASTM Standards, Part 6—Plastics, Rubber. Each standard available separately.[a]

Society of Automotive Engineers
485 Lexington Ave., New York 17.
SAE Handbook. Each AMS available separately.[a]

Federal and Military
Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C.
Each specification available separately.[a]

Commercial
Commodity Standards Div., Office of Technical Services
U. S. Dept. of Commerce, Washington 25, D. C.
Each standard available separately.[a]

American Standards Assn.
70 E. 45th St., New York 17.
Each standard available separately.

Society of Plastics Industry, Inc.
250 Park Ave., New York 17.
Each standard available separately. *Plastics Engineering Handbook of the SPI*, Reinhold Publishing Corp.

Rubber Manufacturers Assn., Inc.
444 Madison Ave., New York 22.
Buyers' Specification for Latex Foam; Compression Range Guide; Glossary of Terms Used by the Mechanical Rubber Goods Industry.

National Electrical Manufacturers Assn.
155 E. 44th St., New York 17.
NEMA Standards Publications, List and Order Blank. Section Laminated Products. Each standard available separately.

Manufacturing Chemists' Assn., Inc.
1625 Eye St., Washington 6, D. C.
Technical Data on Plastics.

[a] See first article of series (Mar '58) for information on index. Use of standards issued by trade associations should not be considered mandatory.

Plated *radiator grilles for automobiles.* American Zinc Institute

5 Rules to Follow in Designing for Plating

This article shows how it is often possible to design a plated part of higher quality and lower cost without sacrificing style or function.

1. Design for uniform plate thickness

In general, an electroplating current tends to flow in a straight line from anode to cathode. Current tends to take the course of least resistance and for this reason electrodeposits tend to build up more on projections and edges rather than on recessed areas. This can be an important factor where a certain minimum thickness is required. If a part is improperly designed a very heavy coating may have to be produced on projected areas in order to achieve a certain minimum thickness on recessed areas. Plate distribution is commonly measured by the ratio of average to minimum plate thickness. The ideal ratio, indicating completely uniform thickness, is 1.0.

1a. Use large angles and radii

The effect of part shape on the thickness of electrodeposits (in this case nickel) is shown in Fig 1 to 4. Note the effect of angles on plate distribution in Fig 1.

As shown, the ratio of average to minimum plate thickness of a right angle is 2.7. This ratio is increased to 3.3 when the angle is closed down to 60 deg. However, when the angle is opened up to 120 deg the thickness ratio drops down to 1.9, a fairly acceptable figure.

It can be proved mathematically that there is no way of plating metal into the apex of a true right angle in one operation. However, it is impossible to produce a true right angle, and in actual practice the angle is usually made with as large a radius as possible. Even

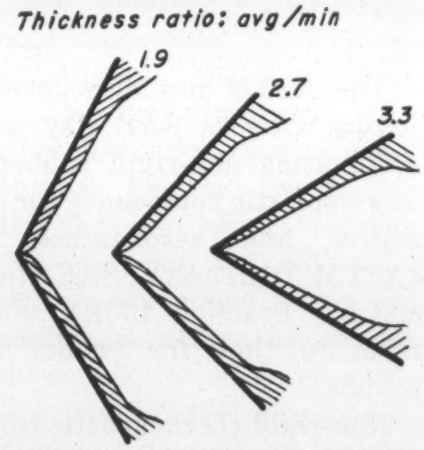


Fig 1—*Large angles make it easier for plate to deposit at apex of angle, insuring uniform plate distribution.*

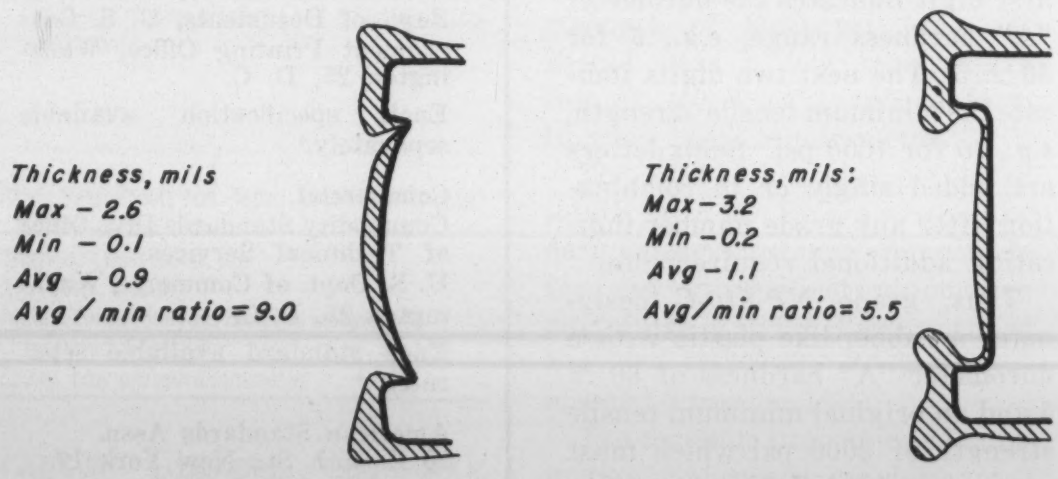


Fig 2—*Large radii reduce danger of too little plating in hard-to-reach areas of a part.*

Adapted from a chapter in the *Electroplating Engineering Handbook*, edited by A. Kenneth Graham, Reinhold Publishing Corp., 1955. Authors of the chapter: C. F. Nixon, Electrochemistry Dept., General Motors Corp.; D. M. Bigge, Engineering Div., Chrysler Corp.; and W. L. Pinner, Engineering Dept., Houdaille-Hershey Corp.

so, it is difficult to obtain uniform plate distribution because of the tendency of electrodeposits to form on the legs of the angle (sometimes called a "robbing" effect).

The effect of sharp recessions or protrusions is further illustrated in Fig 2. Note that the lack of adequate radii at the ends of the central recessed section in the poor design produces a plate distribution of 9.0. The effect of using larger radii is shown in the redesigned part where the plating ratio has dropped down to the more favorable value of 5.5.

Another example of non-uniform plating is shown in Fig 3. The surface of the knob can be given a fairly uniform coating if plated as is. Note, however, that if the same part is fixed to a larger surface a much poorer plating ratio is produced. In effect a right angle is created, and the deposits formed on the flat surface have a robbing effect on the surface at the base of the knob.

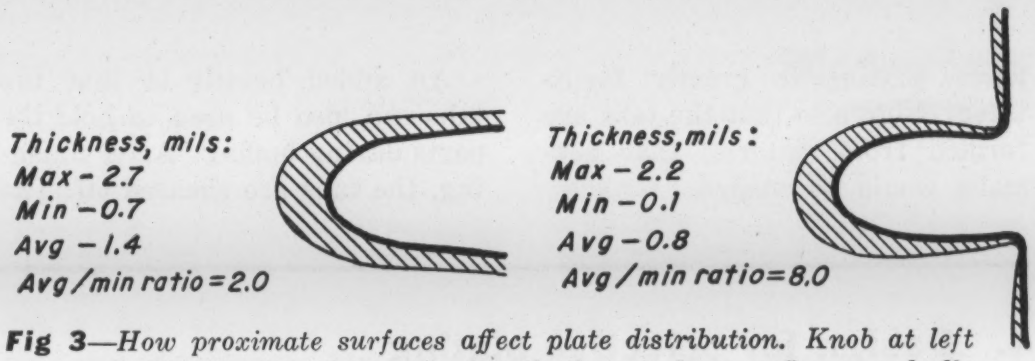


Fig 3—*How proximate surfaces affect plate distribution. Knob at left has good distribution; however, distribution at base suffers markedly when knob is attached to flat surface (right).*

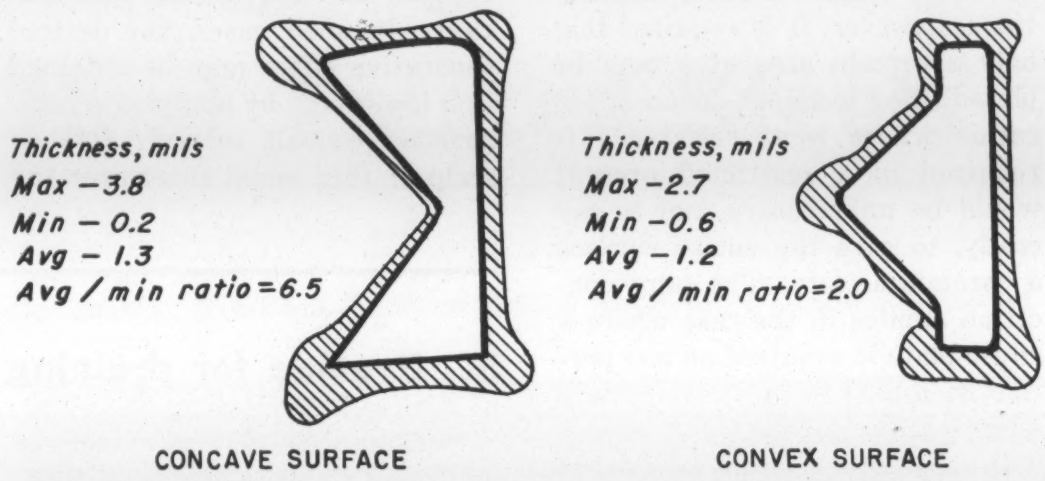


Fig 4—*Convex surfaces can be plated more uniformly than concave surfaces. Note difference in ratio.*

1b. Make recesses shallow and use convex surfaces

If some latitude in design is permitted, try to avoid deep recesses by substituting convex surfaces for concave surfaces. The ratio of average to minimum thickness on the recessed surface in Fig 4 is 6.5. Compare this part with the similar part having a convex surface and a plating ratio of 2.0.

2. Use smooth surfaces

Plating cannot be expected to fill holes or level out rough metal surfaces. Despite advances that have been made in developing leveling deposits, plating cannot remedy the natural defects in raw materials such as seams or pores. Nor can it remedy the defects caused by manufacturing operations.

Gross defects which produce inadvertent contour changes can be plated, but the deposits will not have uniform thickness. Such a condition can affect appearance as well as the durability of the product. Also, it is extremely costly to deposit an excessively thick coating in the hope that extra buffing will cover surface defects.

3. Provide for electrical contact

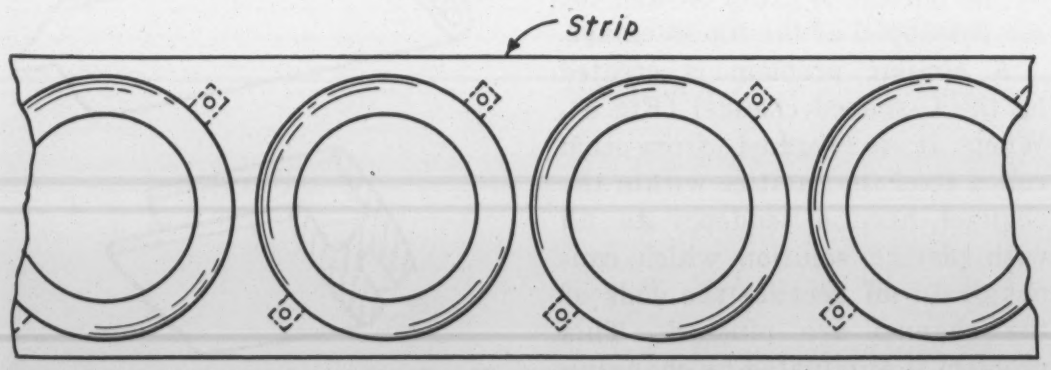


Fig 5—*Contact tabs are designed into rims of these disks to facilitate electrical contact in plating operation.*

A number of clever racking techniques have been devised to facilitate good electrical contact during plating. Nevertheless, quite often a difficult racking problem can be solved by making a simple design change in the product.

Such a solution is illustrated by the thin flexible disks shown in Fig 5. Because of their flexibility, these disks are difficult to hold securely on a plating rack without masking a significant portion of their surface. However, when racking tabs (shown by the dotted lines) are added to the

parts, plating is greatly facilitated. Note also that the tabs are formed from material that normally would be wasted.

An added benefit is that the tabs can also be used to hold the parts during buffing. After finishing, the tabs are sheared off. The brass edges thus exposed are not detrimental since they are not visible after edge clinching operations.

4. Design for selective plating

All surfaces that are submerged in a plating bath will be plated to some extent. In many applications, however, it is required that only a certain area of a part be plated. For example, in an application where wear resistance is required in a restricted area it would be unnecessary, not to say costly, to give the entire surface a chromium plate. The same condition applies in the case where a silver plate is required on one portion of a part to prevent fretting seizure.

In most cases the plater can, at a price, meet restrictions of this sort by using stop-off lacquers or other masking devices, or by only partly immersing the parts during plating. Costly expedients of this kind, however, can often be eliminated by making a design change or by rearranging the manufacturing sequence.

For example, selective plating, as well as two-tone effects, can often be obtained by designing the part in two pieces that can be assembled after plating. Only one of the pieces need be plated, or else each piece can be given a different color plate to provide an interesting two-tone effect.

The two (or more) piece idea can be used in other ways. When the plate is decorative, it sometimes happens that only a small portion of the surface is exposed to view and the appearance of the rest of the surface is insignificant. In such cases, the desired decorative effect may be obtained at a lower cost by applying a comparatively small, suitably finished scalp or thin metal sheet over the important area as in Fig 6. If the plate is also intended to prevent corrosion, the amount of plate required may be reduced by using brass or copper as the base metal for the scalp. This technique is often used in automobile hubcap design.

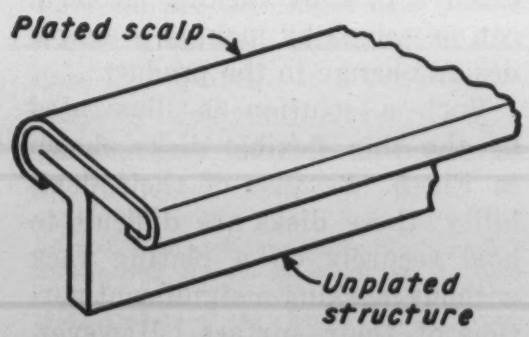


Fig 6—*Plated scalps can be used to decorate only the visible areas, saving cost of overall plating.*

5. Provide for draining and venting

During plating it is extremely important to avoid excessive dragout of solutions in or on the part being plated. Normally, the water rinses provided are adequate to remove plating solutions and prevent contamination. However, when solution trapping ("cupping") occurs, dragout losses may be so high as to cause trouble.

Difficulties of this kind can often be eliminated in the design stage of the product. An example of how this can be done is shown in Fig 7. Because of the limitations of plating equipment the wrap-around bumper must sometimes be positioned vertically in the plating tank. It is evident that the curved ends of the bumper can create problems of drainage and entrapped air. However, placing holes ¼ in. or more in dia at both ends of the bumper makes it possible for the solution at the bottom to drain off and the air entrapped at the top to escape.

A similar problem is created by the U-shaped channel (Fig 8). When it is formed from cold rolled steel the cavities within the channel have a tendency to fill with plating solution which cannot drain off because the ends of the channel are pinched. This problem is eliminated by changing the design to use a solid section, zinc die casting.

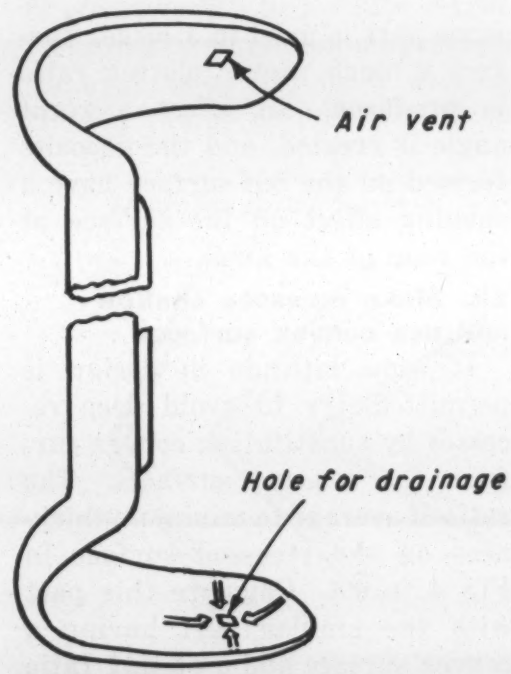


Fig 7—*Bumper has vent at top and drainage hole at bottom to prevent air entrapment, solution dragout.*

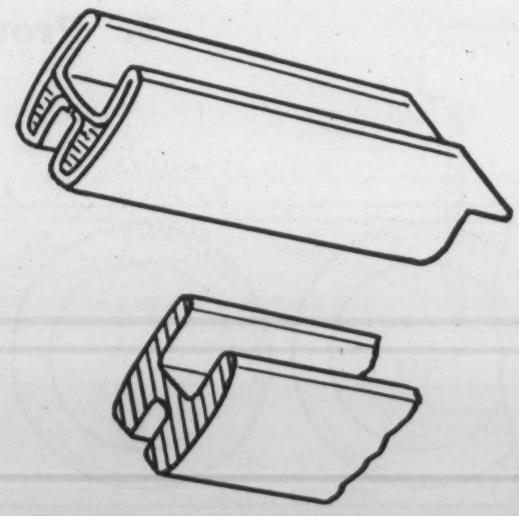


Fig 8—*Switch from sheet channel to solid section zinc die casting eliminates solution entrapment.*

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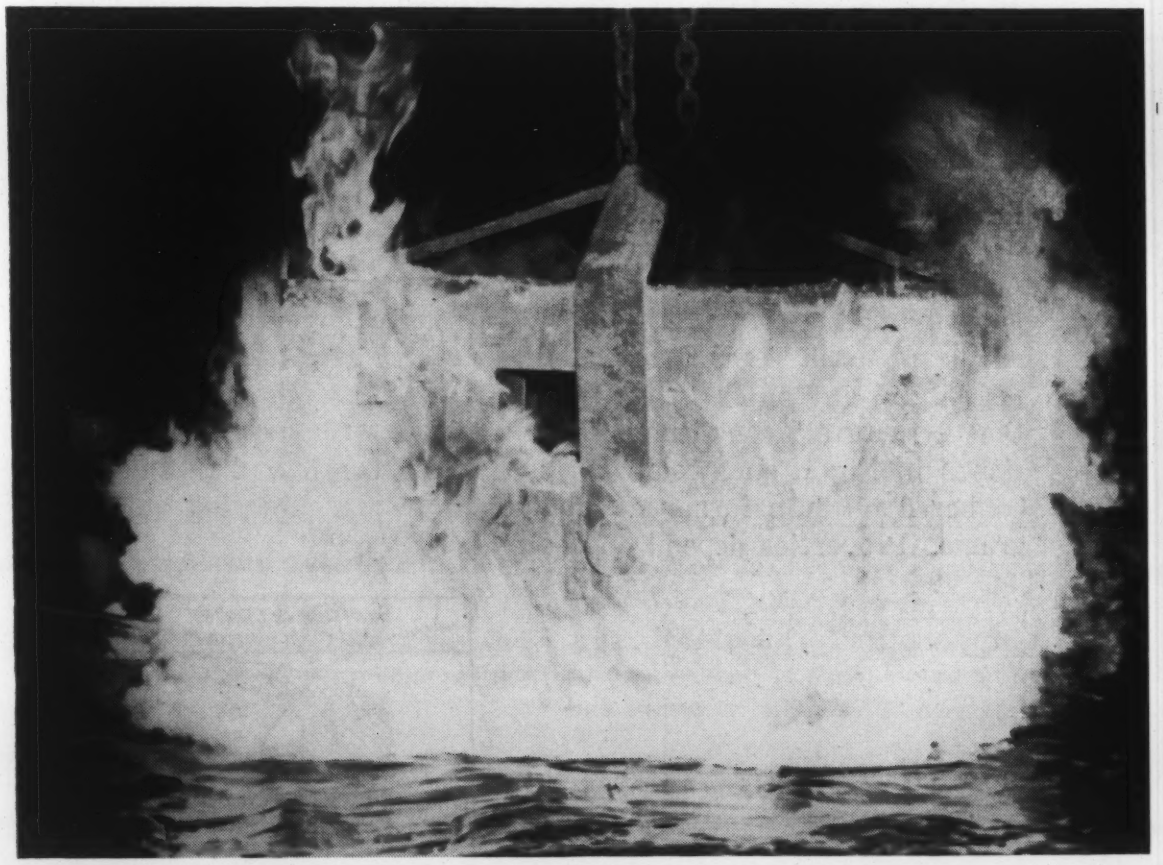
June 1958

Designing with Heat Treated Steels

by John L. Everhart, *Technical Editor, Materials in Design Engineering*



Quenching—*a key step in many heat treatments.*

The properties of steels can be varied widely by heat treatment. This manual tells what results can be achieved by annealing, normalizing, quenching and tempering, martempering and austempering. It includes:

- *Heat treatments and the properties they give*
- *Selecting the steel and the design*
- *Fundamentals of the heat treatment of steel*
- *Definitions of heat treating terms*

The properties of steels can be altered materially by heat treatment. Steels can be made soft and ductile or hard and brittle. Characteristics such as machinability or formability can also be varied considerably.

There are a number of widely recognized methods of heat treatment, and selection of a suitable procedure depends on the properties desired in the finished part. This manual is devoted to a discussion of those methods that alter properties through structural changes. It does not cover surface treatments that alter the composition of the surface layer, such as carburizing, or those that alter surface condition, such as flame hardening. Nor does it cover the precipitation hardening methods used in hardening certain grades of stainless steels. All of these procedures have also been covered previously.

The aim of this manual is to tell the engineer and designer what properties are obtainable through standard heat treatment procedures and thus to assist him in formulating designs of steel parts. After the properties desired in the part have been determined it is the function of the metallurgist to select the heat treatment method required to obtain those properties.

Previous articles on . . .

- **Surface heat treatments**
- **Aging heat treatments**

Surface and aging heat treatments for steel are not covered in this manual. These treatments were covered in the following articles published in this magazine since 1952:

Hard Coatings and Surfaces for Metals, Jan '57, p 121.
Nitriding Stainless Steels in a Salt Bath, Nov '56, p 113.
Which Method for High Speed Surface Hardening? Aug '55, p 103.
Age Hardenable Metals, Oct '54, p 121.
Surface Hardening of Steels and Irons, Oct '53, p 137.
Carburizing of Steels, Oct '52, p 135.
How to Case Harden Steel by Nitriding, May '52, p 90.

Heat treatments and the properties they give

The heat treatment of steel depends on the controlled cooling of the material from an elevated temperature at which austenite is the structural constituent; as shown in Fig 1, such cooling can be based on transformation diagrams. Properties depend on the change in structure resulting from cooling. Heat treatments can be divided into two classes:

1. Those that tend to produce *stable* structures (see discussion of iron-carbon diagram, p 124). These are annealing and normalizing.

2. Those that tend to produce *unstable* structures. These include hardening by quenching, martempering and austempering.

In all heat treating operations, excepting stress relieving, the objective is to obtain a definite structure.

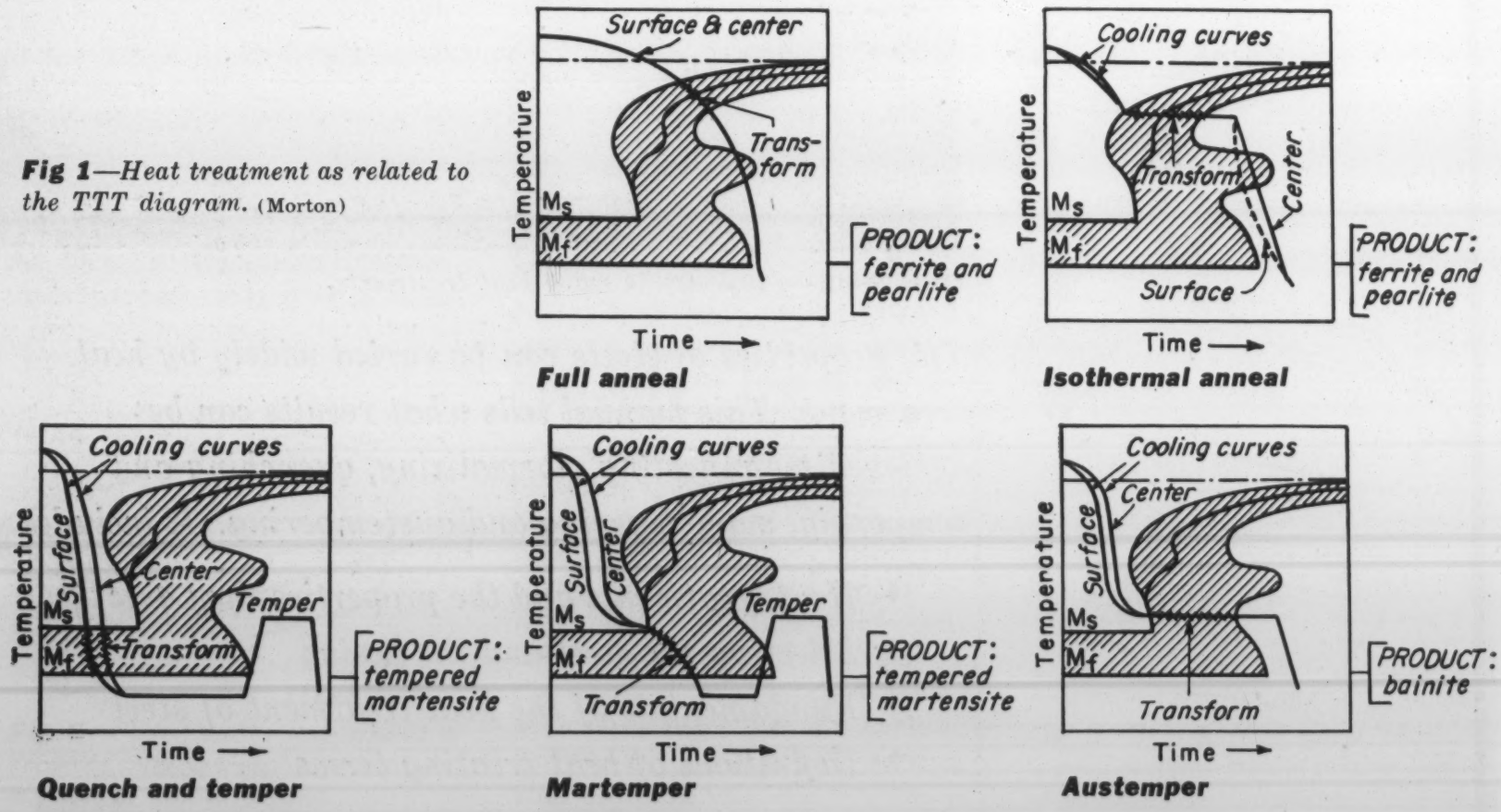


***Fig 1**—Heat treatment as related to the TTT diagram.* (Morton)

Annealing

Steel is annealed to alter various properties, to improve machinability, to alter microstructure or to relieve stresses. Different treatments are required to accomplish some of these objectives, and temperature and rate of cooling are important. Recommended temperatures for annealing carbon steels are given in Fig 2, and mechanical properties of annealed carbon steels in Fig 3. There are a number of different annealing procedures and such terms as full annealing, isothermal annealing and process annealing should be used to distinguish them.

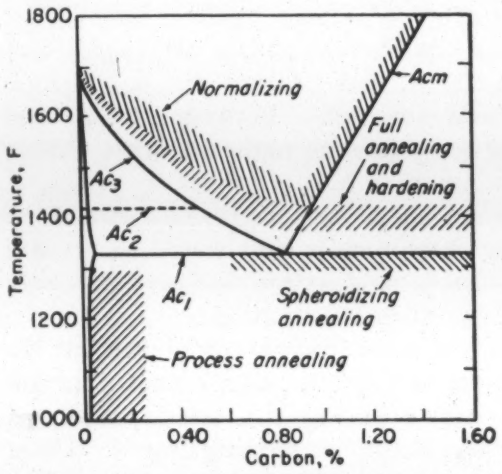


Fig 2—*Recommended temperature ranges for the heat treatment of carbon steels.* (Rosenberg and Digges)

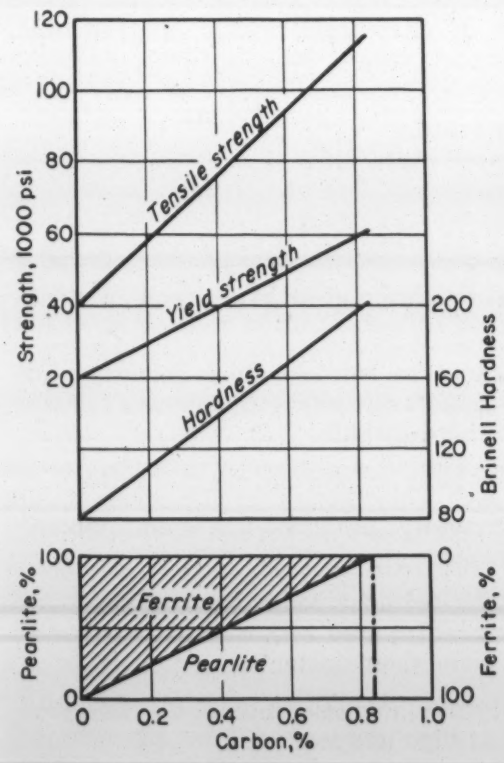
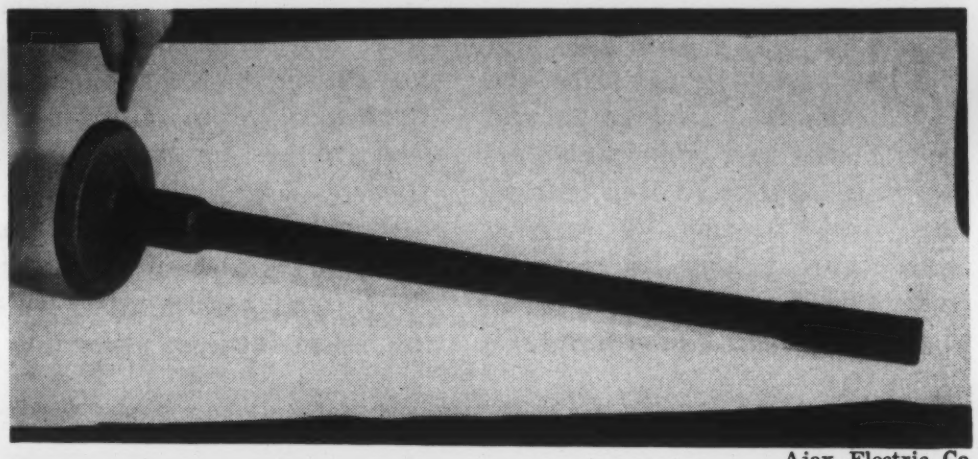


Fig 3—*Mechanical properties and structure as affected by carbon content in annealed steels.*
(Rosenberg and Digges)

Annealing, Normalizing and Stress Relieving— Some Typical Parts

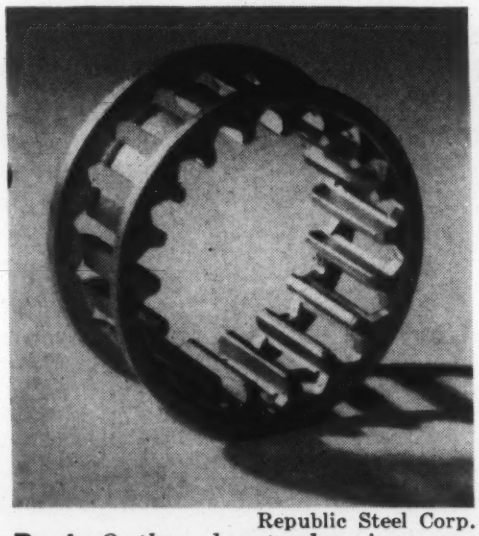


Ajax Electric Co.

Part: *Automotive rear axle shaft.*

Steel: *SAE 8650.*

Heat treatment: *Flange isothermally annealed by 1) austenitizing in a salt bath for ½ hr at 1550 F, and 2) transferring it to a bath at 1100-1300 F until transformation is completed. (Shaft is hardened.)*



Republic Steel Corp.

Part: *Outboard motor bearing cage.*

Steel: *AISI 8620.*

Heat treatment: *Cold drawn bar stress relieved to improve machinability and surface finish.*

Republic Steel Corp.

Part: *Pipe plug.*

Steel: *AISI 4037.*

Heat treatment: *Cold drawn bar stress relieved to upset plugs without excessive increase in hardness.*

Ipsen Industries, Inc.

Part: *Outboard motor crankshaft.*

Steel: *SAE 8620.*

Heat treatment: *Normalized ½ hr in protective atmosphere at 1650 F; cooled in protective atmosphere to 400 F in 2½ hr. Resulting hardness: 196-200 Bhn.*

Full annealing

Full annealing is a softening process in which the steel is heated to a temperature above the transformation range, held for sufficient time to complete the transformation to austenite, and cooled slowly to a temperature below the transformation range. The steel is usually furnace cooled, but it may be removed from the furnace and covered with ashes, mica or lime to retard the cooling rate. Annealing temperatures vary with the carbon content and are generally specified 25 to 50°F above the transformation range for steels containing less than 0.83% carbon, and above the lower limit of the transformation range for higher carbon steels.

Structurally, steels containing up to 0.83% carbon will consist of ferrite and pearlite after annealing, the fineness depending on the rate of cooling. Steels containing more than 0.83% carbon will be composed of pearlite and cementite.

Isothermal annealing is a modification of full annealing that results in better control of the formation of pearlite. After the steel is heated above the transformation range and held for the required time, it is transferred into a bath of molten salt held at a selected temperature below the

Some Fundamentals of Steel Heat Treatment

Iron-carbon diagram

A brief consideration of the iron-carbon diagram is basic to a discussion of the heat treatment of steel. Depending on the temperature, iron exists in two different crystal structures. At temperatures up to 1670 F, the structure is body-centered cubic and is identified, metallographically, as *alpha*. At 1670 F, the structure transforms to face-centered cubic, and this phase is identified as *gamma*. (There is an additional transformation to a body-centered cubic structure, *delta, at* 2550 F, but this phase need not be considered further here.)

Carbon can dissolve in iron, the extent depending on the iron structure. Carbon dissolves in alpha iron to a maximum of about 0.04% at 1330 F. The solid solution formed is called *ferrite*. A great deal more carbon can dissolve in gamma iron, reaching a maximum of 1.7% at 2065 F. This solid solution is called *austenite*. The difference in solubility of carbon in the two phases is the reason why iron-carbon alloys can be hardened by heat treatment. One additional constituent must be considered: iron and carbon form a compound known as *cementite*.

The portion of the iron-carbon equilibrium diagram (simplified, Fig A) that is involved in the hardening of steel consists of four areas separated by three boundaries. Below the A_1 line, the equilibrium phases are ferrite and cementite. Between the A_1 and A_3 lines, the equilibrium phases are ferrite and austenite. Between the A_1 and A_{cm} lines, the phases are austenite and cementite. Above the A_3 and A_{cm} lines, the equilibrium phase is austenite.

The diagram does not show the constituents after heat treatment but rather those phases that would be present if iron-carbon alloys were held at temperature for sufficient time to reach equilibrium conditions.

The diagram applies to pure iron-carbon alloys, but the principles are the same for steels. (An actual diagram for carbon steels is shown in Fig B.) Steels, although essentially iron-carbon alloys containing up to about 1.5% carbon, always contain additional elements, either as intentional additions or as impurities. Thus, the so-called carbon steels contain specified quantities of manganese and silicon. They also contain sulfur and phosphorus as impurities. Steels can be further modified by the addition of chromium, nickel, molybdenum,

EFFECTS OF SOME COMMON ALLOYING ELEMENTS IN STEEL

Element	Usual Range, %	Effect on Transformation Range	Principal Effects
Aluminum	1–2	Slight	Deoxidizer; restricts grain growth; desirable in nitriding steel
Chromium	0.5–30	Raised on heating; lowered on cooling	Increases resistance to corrosion and oxidation; increases high temperature strength; increases hardenability; forms hard carbides
Manganese	1.0–2.0	Lowered on heating and cooling	Increases hardenability; offsets bad effect of sulfur
Molybdenum	0.5–4.0	Raised on heating; lowered on cooling	Increases hardenability; promotes fine grain; opposes temper brittleness
Nickel	0.5–46	Lowered on heating and cooling	Increases hardness without reducing toughness; increases hardenability; used with chromium in stainless steels to make them austenitic
Tungsten	0.5–20	Raised on heating; lowered on cooling	Strong carbide former; increases retention of hardness and strength at high temperatures
Vanadium	0.1–2.0	Little effect	Carbide former; retains fine grain size; increases hardenability; promotes secondary hardness on tempering

Adapted from *Enos and Fontaine*.

transformation range until transformation is completed. The resulting pearlite is more uniform in structure than that obtained on full annealing, and its fineness can be controlled by selection of the transformation temperature. Pearlitic structures generally have good machinability characteristics in carbon and alloy steels having carbon in the range 0.20 to 0.60%, providing the hardness level is satisfactory. This structure gives better results than others in operations such as broaching, tapping, threading, drilling and milling.

Spheroidizing

Spheroidizing is a process of heating and cooling steel that results in the conversion of the carbide into globules. It is usually accomplished by prolonged heating of the steel at temperatures just below the lower transformation temperature. The process is generally applied to carbon steels containing at least 0.60% carbon to improve machinability or to facilitate drawing into wire.

Spheroidized structures are also required with alloy steels having low and medium carbon contents for cold shaping operations such as heading. In alloy steels with high carbon ranges (over 0.60% carbon), spheroidizing is necessary to lower the hardness, thus promoting machinability.

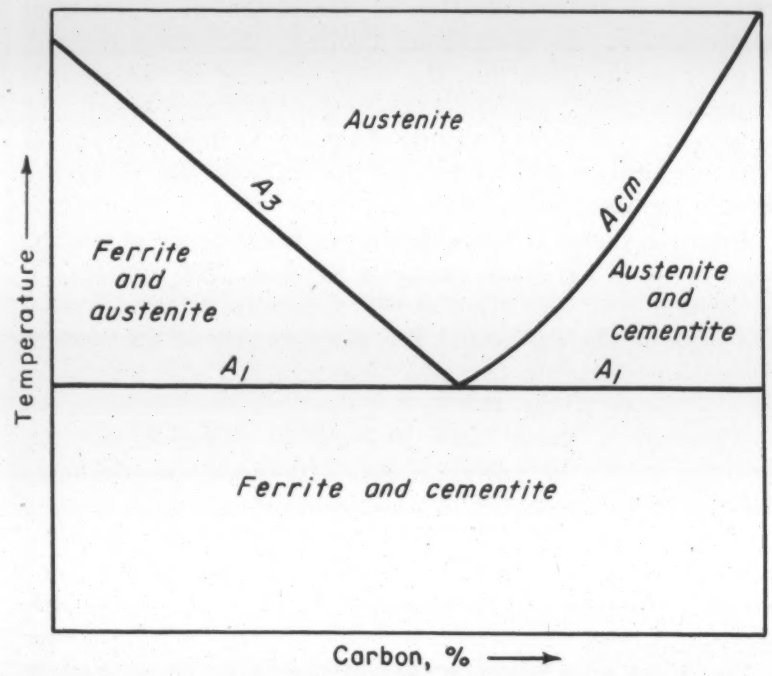


Fig A—*Schematic iron-carbon diagram showing areas important in heat treatment.*

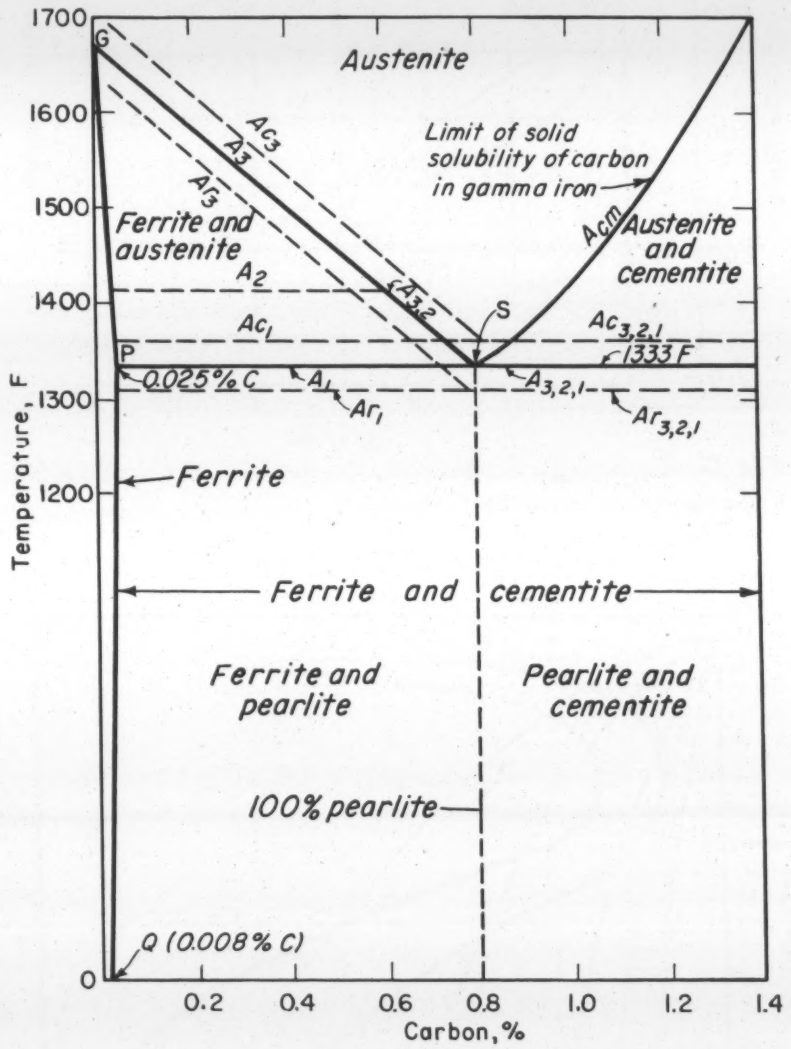


Fig B—*Iron-carbon diagram for steel modified to show Ac and Ar values. Gaps shown between A and Ac or Ar are those for moderately slow rates of cooling or heating.* (Enos and Fontaine)

vanadium or other elements. The principal effects of individual elements are indicated in the accompanying table.

The major effect of the alloying elements on the iron-carbon diagram is to shift the boundary lines between the phases (the A_1, A_3 and A_{cm} lines) and thus change the temperatures at which transformation occurs, and to introduce new phases, mainly alloy carbides. It is not essential to discuss these changes here except to note that because they occur, different steels require different heat treatment temperatures.

Isothermal transformation diagram

Until recently, heat treatments were based on equilibrium diagrams modified to indicate both equilibrium and non-equilibrium conditions. Diagrams of this type give little information on the effects of time, cooling rate and grain size on the structure and resulting mechanical properties. Development of isothermal transformation diagrams (the so-called I-T, TTT or S-curves) has made the control of heat treatment more precise.

Briefly, a time-temperature-transformation (TTT) diagram represents the manner in which an austenitized steel (see definitions, p 130) transforms if held at a constant temperature below the transformation range. A typical diagram (Fig C) shows the time required for transformation to start, to proceed half way, and to be complete at any constant temperature in the range covered by the curves. Use of the diagram makes it possible to predict the response of a steel to any type of cooling from the austenitic condition. The diagram also shows the temperature at which austenite starts to transform to martensite on rapid cooling (M_s), the temperature at which transformation is 50% complete (M_{50}), and the temperature at which transformation is 90% complete (M_{90}).

The shape and location of the curves in a diagram for a specific steel depend on the composition and grain size of austenite. Generally, increasing alloy content or grain size retards transformation (increases hardenability) at any temperature higher than about 900 F (above the

Process annealing

Cold worked low carbon and low alloy steels (up to about 0.25% carbon) can be softened for further working by heating them to temperatures below the transformation range for sufficient time to cause recrystallization of the ferrite grains that have been distorted during cold working. The relatively small pearlite content is generally not affected. Temperatures are usually in the 1000-1200 F range.

Stress relieving

Stress relieving is employed to reduce residual stresses that might be harmful in service, to improve dimensional stability, and to restore ductility after cold working. Steels are generally stress relieved in the 850-1200 F range. The heating time required depends on the grade of steel,

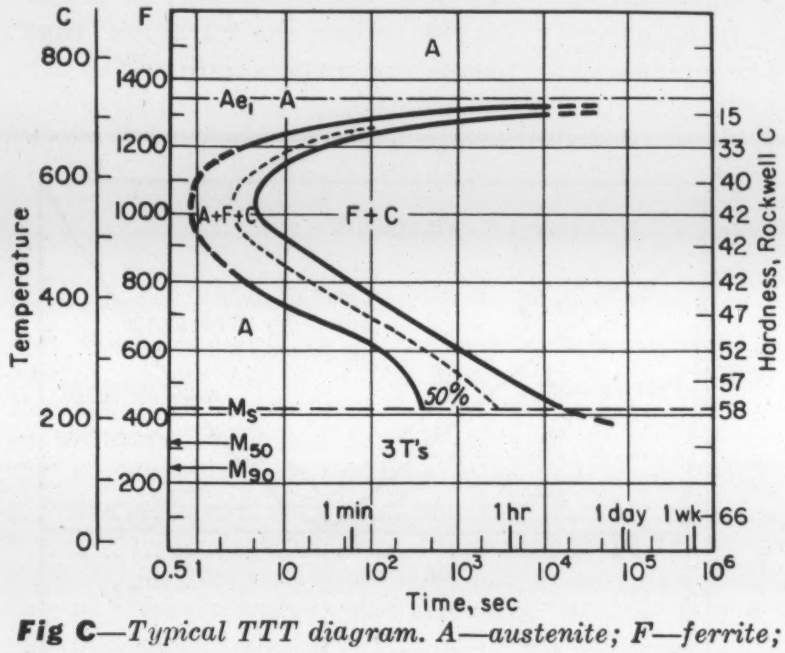
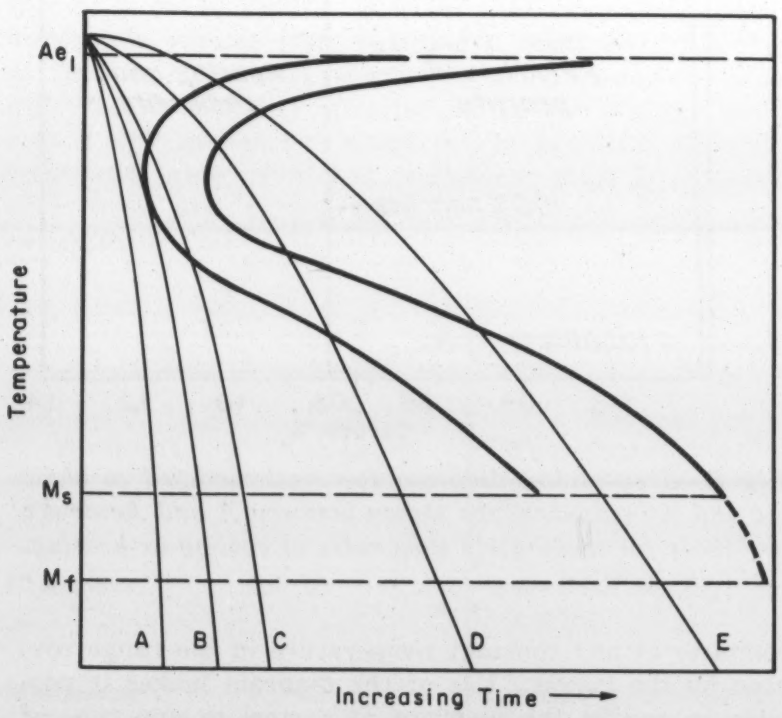


***Fig C**—Typical TTT diagram. A—austenite; F—ferrite; C—cementite.* (U. S. Steel Atlas)



nose of the initial curve). The United States Steel Corp. has prepared and assembled many TTT diagrams. The data are published in two volumes which should be consulted for specific information (see references).

The TTT diagram gives the structures that will be obtained if transformation is completed at a constant temperature. In continuous cooling, the structure will depend on the time that the steel remains in the various transformation regions (i.e., the cooling rate). A schematic continuous cooling diagram is shown in Fig D. The structures obtained from several cooling rates are shown by photomicrographs.

Pearlite forms if transformation takes place above the nose of the TTT curve (roughly between 1300 and 1000 F in carbon and low alloy steels); bainite forms between the nose of the curve and the temperature of martensite formation (roughly between 1000 and 450 F); and martensite forms below 450 F.

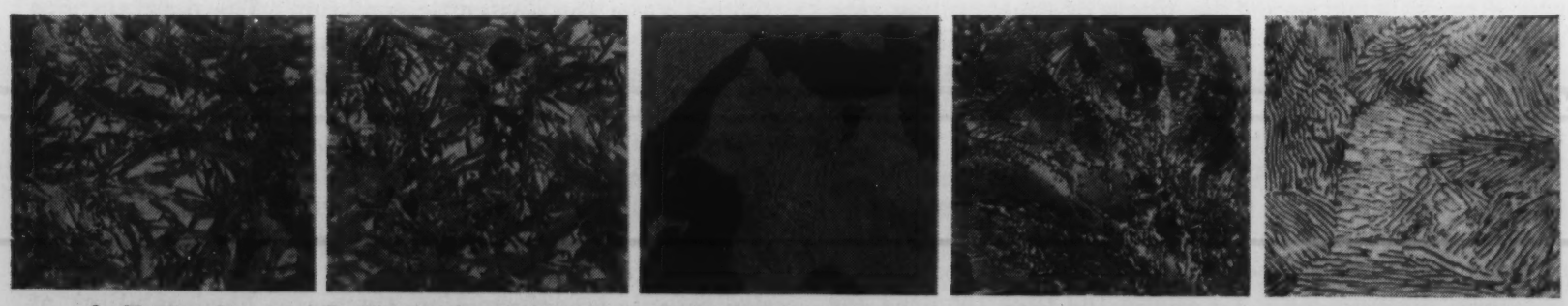
Although a finite time interval is required for the transformation of austenite into either pearlite or bainite, the transformation to martensite is not time dependent. It occurs almost instantaneously and the proportion of austenite transformed depends only on the temperature to which it is cooled.

Hardenability

The most significant practical attribute of a steel is its capacity to be hardened, called hardenability. This term refers to the depth of hardening, or to the size of a piece that can be fully hardened under a given set of cooling conditions—not to the maximum hardness obtainable (Fig E). In a given steel, maximum hardness is dependent almost entirely on the carbon content (see Fig F), whereas depth of hardening depends on the carbon and alloy content and austenitic grain size.

Since the hardness of steel increases as the transformation temperature is lowered to the M_s, it is essential to prevent transformation at the higher temperatures. This requires cooling the steel with sufficient rapidity to pass the nose of the TTT curve before transformation starts.

***Fig D**—Schematic diagram (left) shows relationship between TTT curves, continuous cooling curves and resulting structures (photomicrographs below) of carbon steel.* (Rosenberg and Digges)



A *Martensite*

B *Martensite (with trace of very fine pearlite, shown dark)*

C *Martensite (and very fine pearlite)*

D *Fine pearlite*

E *Coarse pearlite*

magnitude of residual stresses and mass effect of the steel part.

Normalizing

Normalizing is an intermediate process between annealing and hardening. Its purpose is to obliterate the effects of previous heat treatments or cold working, and to produce homogeneous austenite on reheating for hardening or annealing. Normalizing is performed by heating the steel above the upper transformation range and cooling in still air. Normalizing temperatures are generally about 100°F above the transformation range; recommended normalizing temperatures for carbon steels are indicated in Fig 2. De-

The cooling rate that will just permit the material to pass the nose of the curve before transformation starts is called the critical cooling rate and can be determined from a continuous cooling diagram.

In general, the suitability of a steel for a given heat treatment is determined by its hardenability, which in turn is influenced by carbon and alloy content. Increasing the alloy content delays the start of transformation and increases the time for completion. Since the surface of a part cools faster than its center, delaying the transformation permits the center of a part to pass the nose of the TTT curve. As a result, alloy steels can be quenched to martensite more slowly than carbon steels. Different alloying elements differ greatly in their effects on transformation rates, but the effects of these elements are cumulative.

There are a number of methods of determining hardenability experimentally, one of the most widely used being the Jominy test. Details of this test method are available in several of the references cited at the end of this manual. The test consists of end-quenching a bar of steel under standardized conditions and determining the hardness at intervals of 1/16 in. along the length of the bar. A Jominy graph is shown in Fig G. The depth of hardening in a round bar is related to the Jominy test bar by graphs such as that shown in Fig H. Bands defining the maximum and minimum Jominy hardness to be expected in commercial heats of alloy steels have been established and it is possible to purchase steels (known as H-steels) with hardenability guaranteed to fall within these bands.

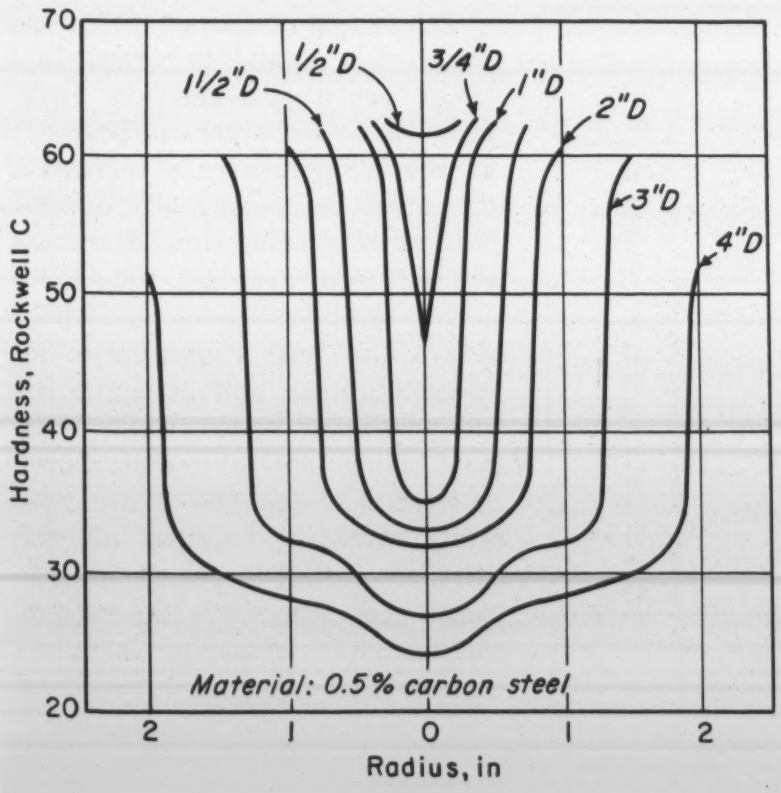


Fig E—*Variation in hardness across section of different size rounds quenched in water from 1530 F.* (Rosenberg and Digges)

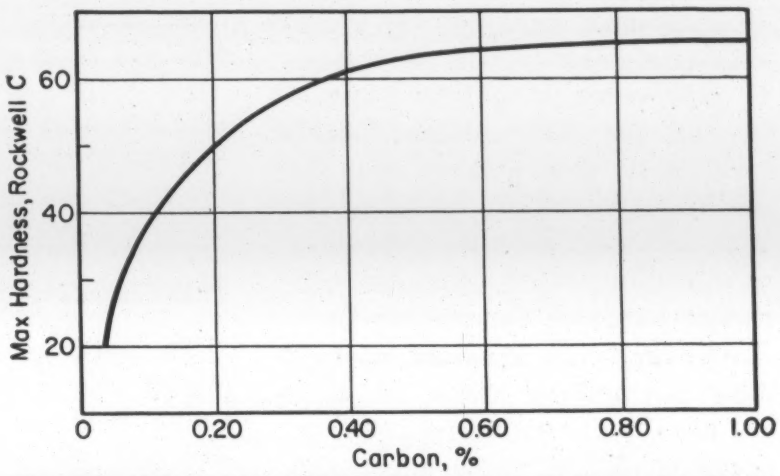


Fig F—*Effect of carbon content on maximum hardness obtainable in steels.* (E. F. Houghton & Co.)

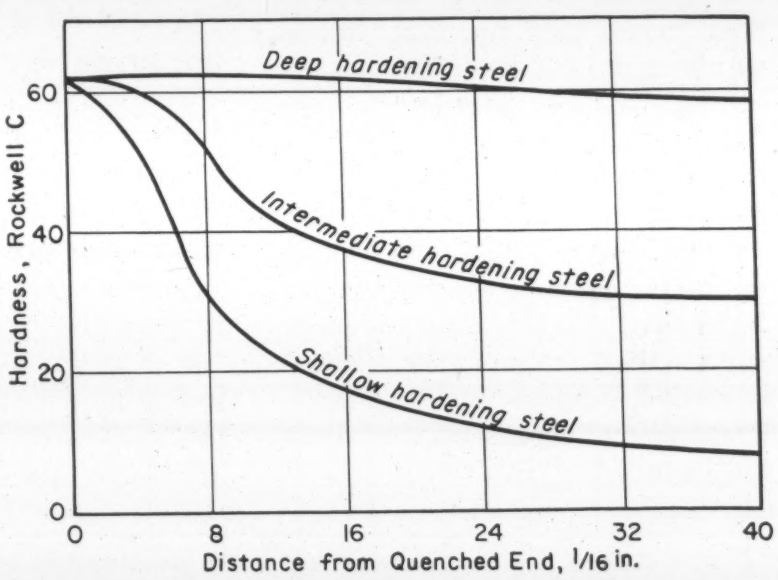


Fig G—*Typical hardenability curves obtained in Jominy test.* (Rosenberg and Digges)

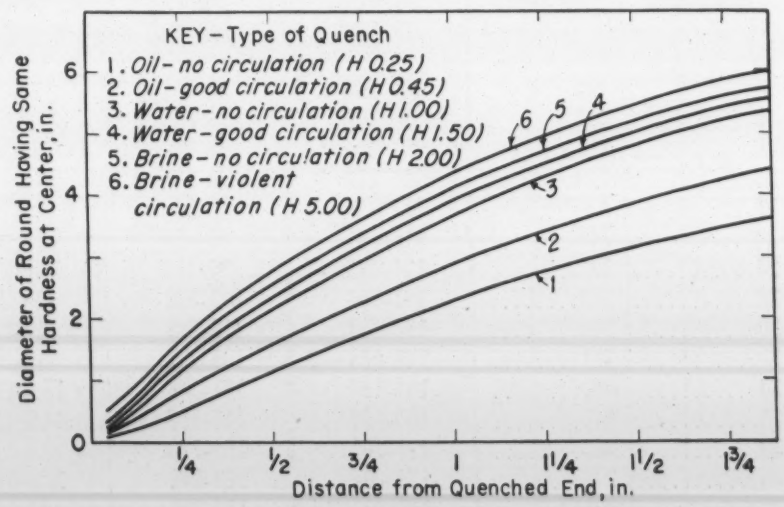


Fig H—*Relation between distance from quenched end on standard Jominy test bar and diameter of round that will have same hardness at center.* (Bethlehem Steel Co.)

pending on the composition, the structures obtained are pearlite, pearlite and ferrite, or pearlite and cementite. Normalized structures are usually finer and more uniform than those resulting from full annealing.

High temperature normalizing (at temperatures more than 100°F above the transformation range) is sometimes employed for grain-coarsening low carbon alloy steels to improve machinability. Depending on the alloy content, steels treated in this manner may be machined in the air cooled condition, or may require tempering or annealing after normalizing to reduce hardness for machining.

Although the medium carbon, alloy engineering steels are usually used in the quenched and tempered condition, some sheet and tubing alloys are used in the normalized condition. Among these are the 0.3% carbon 4130 and 8630 types used for such things as aircraft fuselages. The carbon content is sufficiently low to permit good weldability, and the alloy confers sufficient strength for many uses without quenching. Normalizing is often followed by tempering to raise the yield point. Normalizing is also used for large parts that cannot be liquid quenched because of their size. Properties of representative steels are included in Table 1.

TABLE 1—EFFECT OF TEMPERING AFTER NORMALIZING
(On Properties of Steel Tube)

Steel	Tube Size, in.	Normalized from 1650 F			Tempered at 900 F after after Normalizing		
		Ten Str, 1000 psi	Yld Str (0.2% offset), 1000 psi	Elong (2 in.), %	Ten Str, 1000 psi	Yld Str (0.2% offset), 1000 psi	Elong (2 in.), %
4130	¾ x 0.035	122	70	17.5	113	90	19
	2¼ x 0.25	99	65	39	100	70	39
8630	½ x 0.037	112	57	20	101	82	22
	1 x 0.063	108	60	25	101	80	26
	2 x 0.25	96	61	43	93	69	27

Source: *Archer, Briggs and Loeb.*

Hardening

To harden steel, it must be heated above the transformation range, held for sufficient time to complete the transformation to austenite, removed from the furnace, and quenched in a cooling medium. The quench can be continued to room temperature, or an isothermal step at some elevated temperature can be included. Hardening procedures include quenching and tempering, martempering and austempering.

Quenching and tempering

In the simplest procedure, steel is quenched to room temperature (or slightly above) in air, oil, water or brine; air has the slowest cooling rate, brine the fastest. Selection of the quenching medium depends on the composition of the steel and the section size, the objective being to cool fast enough to pass the nose of the TTT curve before transformation starts and thus obtain a martensitic structure. If the rate of heat extraction is too slow, partial transformation will occur before the M_s (martensite start) temperature is reached, and the steel will contain transformation products other than martensite; such a condition is called "slack-quenched."

The structure of properly quenched steel consists entirely of martensite—a hard, brittle, unstable constituent. Hardness depends primarily on the carbon content of the steel. To relieve internal stresses, restore ductility and improve the toughness, quenched steel must be tempered, an operation that usually reduces the hardness.

Tempering requires reheating the steel to a suitable temperature below the transformation range (usually between 300 and 1200 F); as the temperature is increased, the steel becomes more ductile, but, at the same time, hardness and strength decrease. The tempering temperature is selected to obtain the best compromise between ductility and strength for the particular application. With most alloy steels, temperatures between 500 and 700 F are generally avoided because of the brittleness that develops in this range. In most steels the rate of cooling after tempering is unimportant. The structure resulting

TABLE 2—RELATIONSHIP BETWEEN MECHANICAL PROPERTIES AND HARDNESS OF STEEL[a]

Rockwell C Hardness	Brinell Hardness	Tensile Strength, 1000 psi	Yield Point, 1000 psi	Elong (2 in.), %	Red. of Area, %
14	197	93–103	69–78	22–28	60–68
16	207	98–108	73–84	21.5–27.5	59–67
18	217	103–114	76–90	21–27.5	58–66
20	223	106–117	79–93	20.5–26.3	57.5–65.5
22	235	112–124	85–99	20–25.5	56.5–64.5
24	248	118–131	92–107	19.5–24.5	55–63
26	262	124–138	99–114	18.5–24	54–61.5
28	277	131–146	107–122	18–22.5	52–60
30	293	138–154	116–131	17–22	51–59
32	311	146–164	125–141	16–20.5	49–57
34	321	151–170	131–146	15.5–20	48–56
36	341	160–180	141–157	14.5–18.5	46–54
38	363	171–193	153–170	13.5–17	43.5–51.5
40	379	178–201	163–179	12.5–16	42–50
42	401	188–222	176–185	11–15	40–49

[a]This table is more accurate for steels containing 0.30% or more carbon than for lower carbon steels. The latter generally have lower yield points than those shown in the table.
Source: Joseph T. Ryerson & Son, Inc.

from tempering fully hardened steel is called *tempered martensite*.

Properties—The properties obtainable on quenching and tempering can be presented in graphical form. Graphs similar to Fig 4 can be furnished by most steel companies both for the standard steels and for their proprietary grades. Such graphs give a great deal of information, but they are usually based on tests of a single heat of steel. Normal variations in composition from heat to heat, of course, will affect the properties.

However, such graphs for individual steels are not essential. The properties of heat treated steels are largely dependent on their structure. It is not surprising, therefore, that a comparison of a large number of carbon and alloy steels of medium carbon content places them all within a rather narrow band of mechanical properties, providing the steels have been fully quenched to martensite and tempered. The variation in properties to be expected in such steels is shown in Table 2. Individual heats of the same grade may have properties near the upper or lower limit of the range, and variations in quality may cause some spread in the results, but properly made and heat treated steels will fall within this normal expectancy range. This table, or the graphical representations used in the *SAE Handbook*, for example, will be as accurate in predicting the properties of a specific steel as the individual graph for that steel. In general, the properties in Table 2 were obtained on relatively small diameter bars.

Mass effect—The depth to which a steel will harden on quenching depends on its *hardenability* (see accompanying discussion, p 126) and the size and shape of the part (*mass effect*). Cooling rates decrease with increase in section size. If the cooling rate is fast enough to produce martensite, further increases in rate will not affect the properties or structure of medium carbon steel. If the rate is not fast enough to prevent formation of other constituents, changes in rate will result in changes in the amount and type of the non-martensitic constituent and the mechanical properties will be affected.

Maximum cooling rate is limited by the rate at which heat can be removed from the surface; the highest theoretical rate would be attained if the surface temperature were instantaneously lowered to that of the quenching medium. This rate can be approached in practice by using large quantities of water or brine and agitating the bath to achieve intimate contact with the steel. However, drastic quenching sets up severe temperature gradients in the steel with resulting internal stresses that can cause distortion or sometimes cracking of the piece; therefore, less drastic quenching is often used.

The mass effect can be indicated most satisfactorily by testing specimens from large bars. Fig 5 shows the effect of mass on the mechanical properties of several steels. In their En Steels, the British recognize the effect of

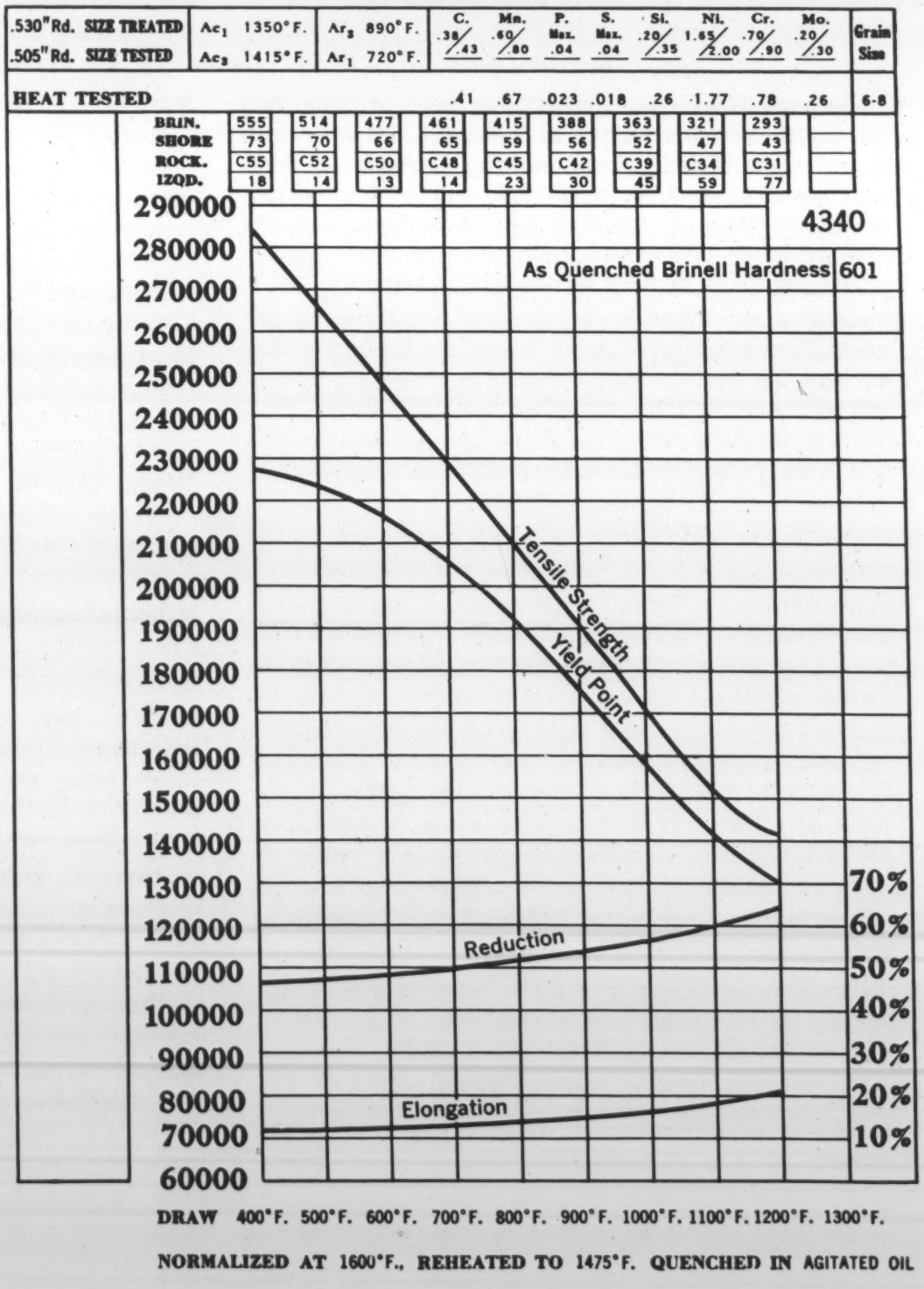


Fig 4—*Typical properties of a representative steel, AISI 4340.* (Bethlehem Steel Co.)

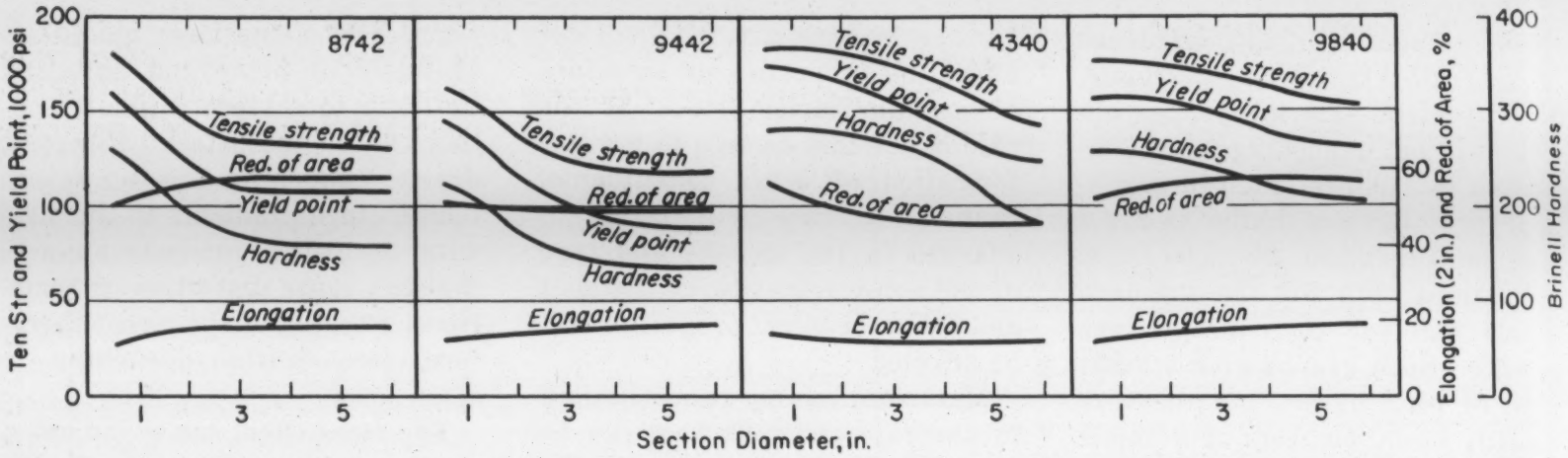


***Fig 5**—Effect of section size on the tensile properties of several steels after oil quenching and tempering at 1000 F. In sections over 1 in., properties were determined on samples cut midway between surface and center.*

(Archer, Briggs and Loeb)

section size on properties by including limiting sizes ("ruling sections") up to which a given steel, when hardened and tempered within specified temperature limits, can be given certain standard ranges of mechanical properties.

Slack quenching—The properties of slack-quenched (incompletely hardened) steels cannot be presented in normal expectancy bands or tables. Even slight variations in composition or heat treatment can cause appreciable differences in the non-martensitic constituents. However, two generalizations can be made, 1) the properties of incompletely hardened steel are inferior to those of fully hardened and tempered steel, and 2) the degradation in property values depends on the hardness of the steel after heat treatment; a

Definitions of Terms Relating to Heat Treatment

Annealing—Heating to and holding at a suitable temperature and then cooling at a suitable rate for such purposes as reducing hardness, improving machinability, facilitating cold working, producing a desired microstructure, or obtaining desired mechanical, physical or other properties. Definitions of more specific terms are given in their alphabetical positions.

Austempering—Quenching a ferrous alloy from above the transformation range in a medium having a rate of heat abstraction high enough to prevent formation of high temperature transformation products; then holding the alloy until transformation is complete at a temperature below that of pearlite formation and above that of martensite formation.

Austenite—A solid solution in which gamma iron is the solvent.

Austenitizing—Forming austenite by heating a ferrous alloy into the transformation range (partial austenitizing) or above the transformation range (complete austenitizing).

Bainite—A decomposition product of austenite consisting of an aggregate of ferrite and carbide. In general, bainite will form isothermally at temperatures below those at which very fine pearlite is the decomposition product and above that where martensite begins to form on continuous cooling (M_s temperature).

Cementite—A compound of iron and carbon known as iron carbide.

Cold treatment—Cooling to a low temperature for the purpose of obtaining desired conditions or properties, such as dimensional or structural stability.

Eutectoid steel—Steel containing 0.83% carbon.

Ferrite—A solid solution in which alpha iron is the solvent.

Full annealing—Annealing a ferrous alloy by austenitizing, then cooling slowly through the transformation range.

Hardenability—In a ferrous alloy, the property that determines the depth and distribution of hardness induced by quenching.

Hardening—Increasing the hardness by suitable treatment, usually involving heating and cooling.

Heat treatment—Heating and cooling a solid metal in such a way as to obtain desired conditions or properties. Does not include heating for the sole purpose of hot working.

Homogenizing—Holding at high temperature to eliminate or decrease chemical segregation by diffusion.

Hot quenching—Quenching in a medium at an elevated temperature.

Hypereutectoid steel—Steel containing more than 0.83% carbon.

Hypoeutectoid steel—Steel containing less than 0.83% carbon.

Interrupted quenching—Quenching in which the metal object being quenched is removed from the quenching medium while the object is at a temperature substantially higher than that of the quenching medium.

Isothermal annealing—Austenitizing a ferrous alloy, then cooling and holding at a temperature at which austenite transforms to a relatively soft ferrite-carbide aggregate.

Isothermal transformation—A change in phase at any constant temperature.

Martempering—Quenching an austenitized ferrous alloy in a medium at a temperature in the upper part of the martensite range, or slightly above that range, holding in the medium until the temperature throughout the alloy

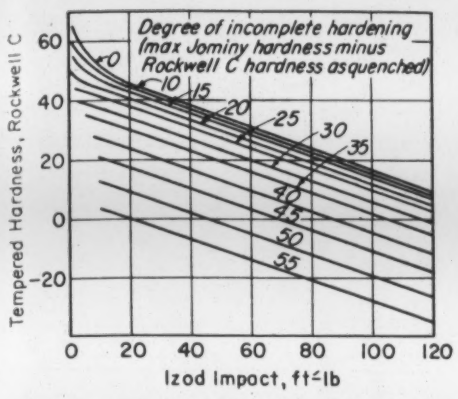


Fig 6—*Effect of incomplete hardening on the impact strength of alloy steels.* (Archer, Briggs and Loeb)

small amount of a non-martensitic constituent can cause a significant loss in toughness at high hardness values.

Briefly, the effects of slack quenching are:

1. The hardness-tensile strength relationship is unchanged because this relationship is not structurally sensitive.

2. The yield strength is significantly lowered.

3. Elongation and reduction of area are decreased.

4. The notched bar impact toughness is seriously affected (Fig 6 and 7).

For tensile strengths in the range 100,000 to 200,000 psi, steels having a quenched structure consisting of martensite and bainite will have a lower yield ratio, a lower endurance ratio, and lower elongation and reduction of area values after tempering than steels having a quenched structure consisting entirely of martensite. However, steels with martensite plus bainite structures have properties considerably better than steels that have martensite and pearlite structures. Therefore it is advisable to select a steel with sufficient hardenability so that the quenched structure will not have

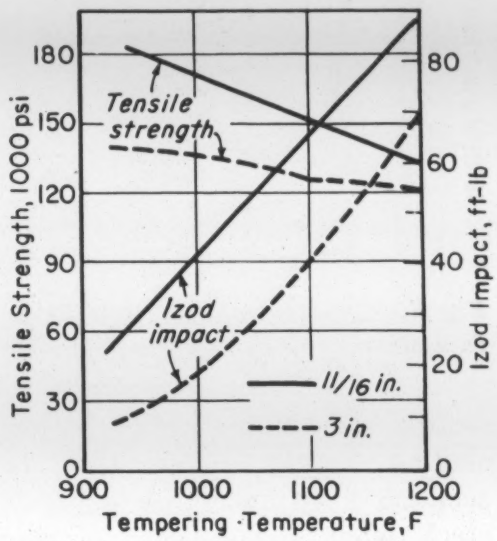


Fig 7—*Comparison of properties after tempering: completely hardened (solid line) vs incompletely hardened (slack quenched) steel.* (Archer, Briggs and Loeb)

is substantially uniform, then allowing the alloy to cool in air through the martensite range.

Martensite—An unstable constituent in quenched steel, formed without diffusion and only during cooling below a certain temperature known as the M_s temperature.

Martensite range—The temperature interval between the M_s and M_f. (See transformation temperature.)

Normalizing—Heating a ferrous alloy to a suitable temperature above the transformation range, then cooling in still air to room temperature.

Pearlite—The lamellar aggregate of ferrite and carbide.

Quench hardening—Hardening of ferrous alloy by austenitizing, then cooling rapidly enough so that some or all of the austenite transforms to martensite.

Quenching—Rapid cooling.

Recrystallization annealing—Annealing cold worked metal to produce a new grain structure without phase change.

Secondary hardening—Tempering certain alloy steels at certain temperatures so that the resulting hardness is greater than that obtained by tempering the same steel at some lower temperature.

Soaking—Prolonged holding at a selected temperature.

Spheroidizing—Heating and cooling to produce a spheroidal or globular form of carbide in steel.

Stress relieving—Heating to a suitable temperature, holding long enough to reduce residual stresses, then cooling slowly enough to minimize the development of new residual stresses.

Temper brittleness—Brittleness that results when certain steels are held within or are cooled slowly through a certain range of temperature below the transformation range.

Tempering—Reheating a quench hardened or normalized ferrous alloy to a temperature below the transformation range, then cooling at any rate desired.

Time quenching—Interrupted quenching in which the duration of holding in a quenching medium is controlled.

Transformation ranges—Those ranges of temperature within which austenite forms during heating and transforms during cooling.

Transformation temperature—The temperature at which a change in phase occurs. All the changes defined below, except the formation of martensite, occur at lower temperatures during cooling than during heating and depend on the rate of change of temperature. The following symbols are used for irons and steels:

Ac_{cm}—In hypereutectoid steel, the temperature at which the solution of cementite in austentite is completed during heating.

Ac_3—The temperature at which transformation of ferrite to austenite is completed during heating.

Ae_1 Ae_3, Ae_{cm}—The temperatures of phase changes at equilibrium in the figure on page 125, the *e* has been omitted.

Ar_{cm}—In hypereutectoid steel, the temperature at which precipitation of cementite starts during cooling.

Ar_1—The temperature at which transformation of austenite to ferrite or to ferrite plus carbide is completed during cooling.

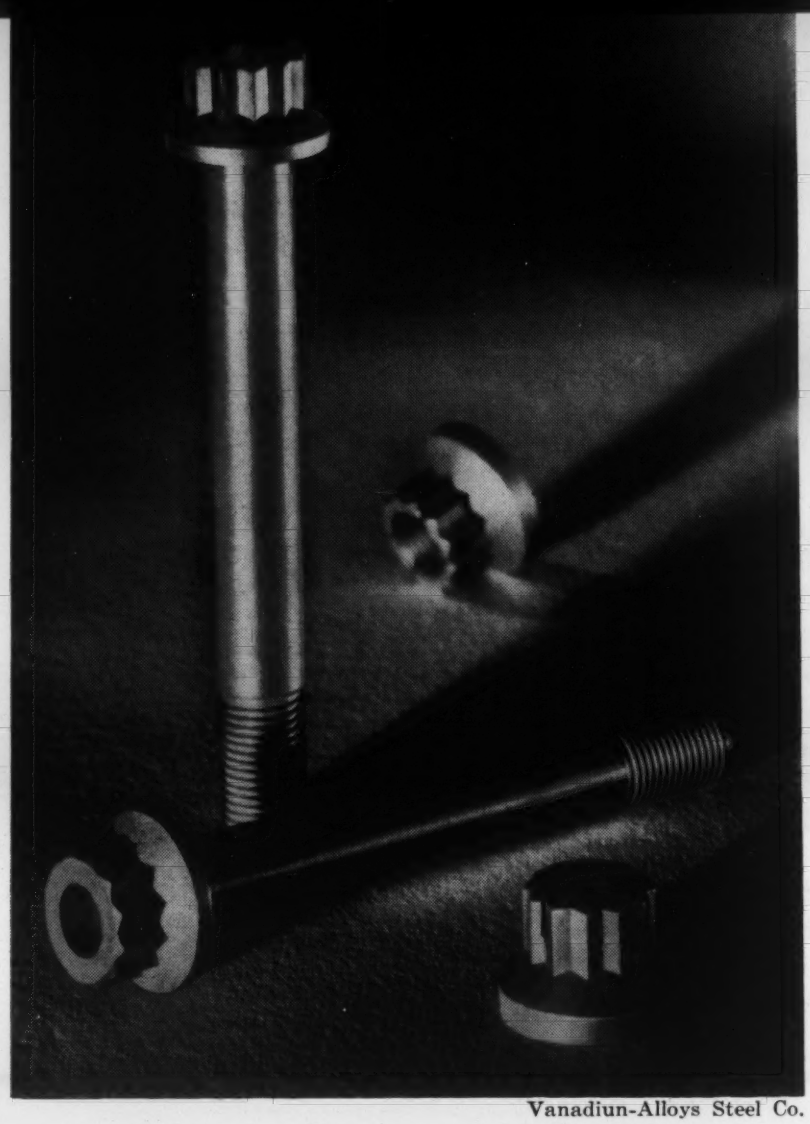
Ar_3—The temperature at which austenite begins to transform to ferrite during cooling.

M_s—The temperature at which transformation of austenite to martensite starts during cooling.

M_f—The temperature at which martensite formation finishes during cooling.

Sources: ASTM E44-50 T; *Metals Handbook*, 1948 Ed.

Quenching and Tempering —Some Typical Parts

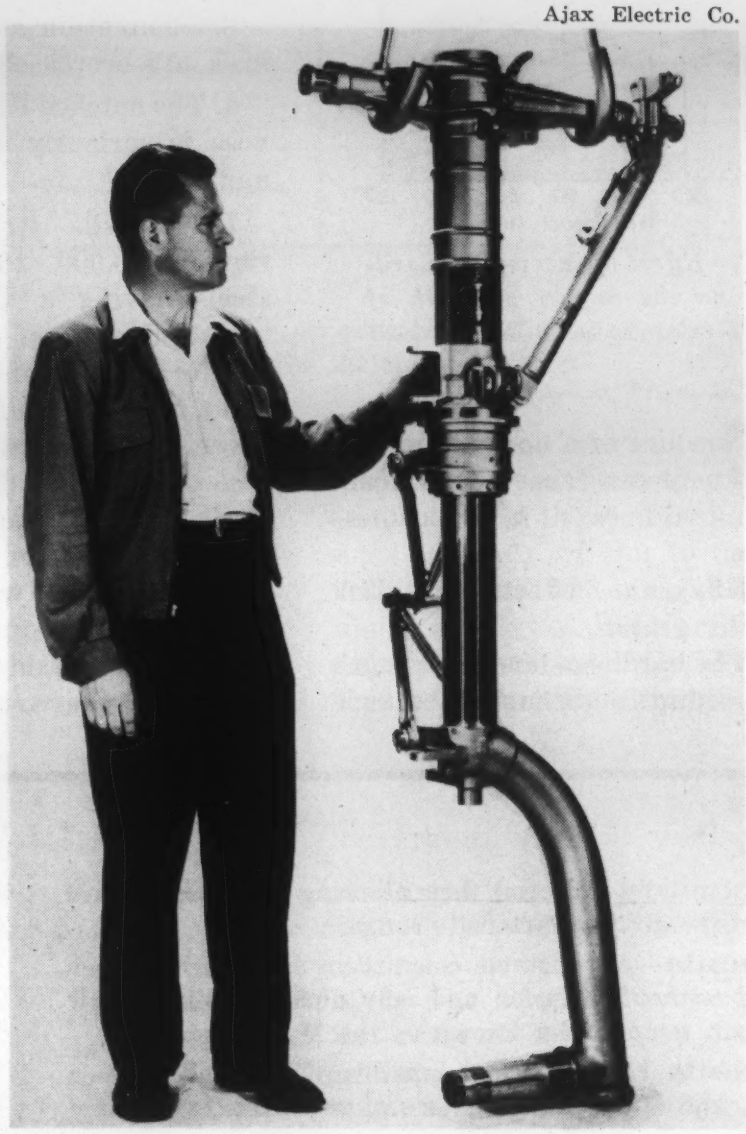


Vanadiun-Alloys Steel Co.

Part: *Aircraft fastener for service to 900 F.*
Steel: *VascoJet 1000 (modified 5% chromium steel).*
Heat treatment: *Austenitized at 1800-1900 F; air cooled; double tempered at 950-1100 F.*
Properties:

	Room Temp	900 F
Ten Str, 1000 psi	*260-280*	*205*
Yld Str (0.2% offset), 1000 psi	*215-230*	*160*
Elong (in 4D), %	*7-8*	*10*
Red. of Area, %	*25-30*	*35*
Rockwell Hardness	*C52-54*	—

Ajax Electric Co.

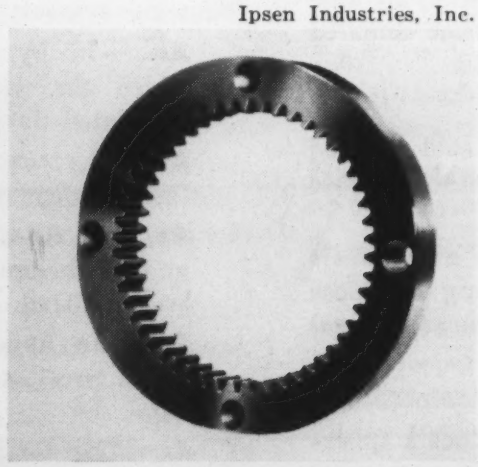


Part: *Aircraft landing gear welded assembly.*
Steels: *4340, 4140, 4130.*
Heat treatment: *Austenitized in a salt bath 70 min at 1525 F; quenched in oil at 140 F; tempered at 880 F.*

Leeds & Northrup Co.

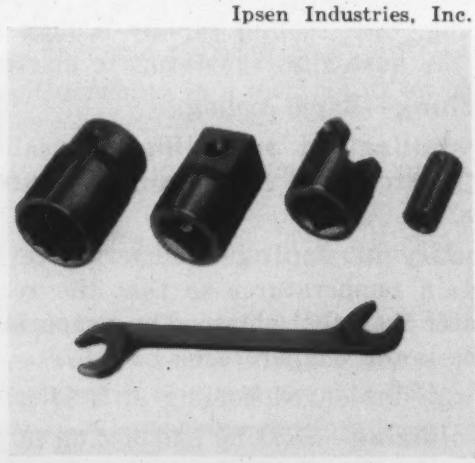
Part: *Drive sprocket for power shovel.*
Heat treatment: *Austenitized in protective atmosphere 1 hr at 1650 F; water quenched; hub induction annealed; entire piece tempered to adjust hardness of teeth and relieve stresses.*
Hardness: *Hub, 200 Bhn; teeth 350 Bhn.*

Ipsen Industries, Inc.



Part: *Ring gear for pneumatic tool.*
Steel: *SAE 4140.*
Heat treatment: *Austenitized in protective atmosphere at 1550 F; quenched in oil at 250 F; tempered. (Maximum change in o.d.—0.002 in.)*
Hardness: *Rockwell C45-50*

Ipsen Industries, Inc.



Parts: *Ignition and socket wrenches.*
Steel: *SAE 4140.*
Heat treatment: *Austenitized in protective atmosphere at 1550 F; quenched in oil at 150 F; tempered.*
Hardness: *Rockwell C40-50.*

Typical martempered and austempered parts are shown on p 135.

appreciable quantities of pearlite in the center of the piece.

Martempering

Martempering is a modification of quenching and tempering designed to equalize the temperature throughout the steel part before transformation occurs. It involves austenitizing the steel, quenching in a bath at a temperature slightly above the M_s temperature, holding for sufficient time to equalize the temperature throughout the part but not long enough to permit transformation to start, and air cooling to room temperature. In this process the transformation of austenite into martensite occurs under low transformation and thermal stresses because of the small temperature differential between surface and center of the steel, and internal stresses and distortion are minimized. The steel is subsequently tempered to the desired hardness.

Martempering is suitable for carbon steels up to $\frac{3}{8}$ in. thick and, depending on the alloy content, alloy steels up to 6 in. thick. Maximum hardness obtainable is Rockwell C67.

Austempering

During the investigation that led to the development of the isothermal transformation (TTT) diagrams, Bain and his co-workers in the United States Steel Corp. discovered an intermediate structural constituent between pearlite and martensite. This constituent, formed between the nose of the TTT curve and the M_s temperature, is known as bainite. Austempering is an isothermal heat treating process that results in the transformation of austenite into bainite instead of martensite.

Austempering, like martempering, requires that the steel be austenitized and transferred into a constant temperature bath. However, in austempering, the bath is held at a temperature above the M_s point and the part must remain in the bath until transformation to bainite is completed. After transformation, the steel can be either air cooled or water quenched.

Austempering is suitable for carbon steels up to $\frac{1}{4}$ in. thick and, depending on the alloy content, alloy steels up to 2 in. thick. Maximum hardness obtainable is Rockwell C54. Generally no additional heat treatment is required. However, a modified procedure is sometimes used in which the transformation to bainite is carried out at a temperature just above the M_s temperature; tempering at a higher temperature then results in the formation of tempered *bainite*.

The transformation of austenite to bainite occurs under low transformation stresses; internal residual stresses and distortion are minimized. The properties of bainite are similar to those of tempered martensite of the same hardness, but toughness of some steels is said to be somewhat greater.

Selecting the steel and the design

In selecting a steel for a specific part, the most important consideration is whether the required mechanical properties can be obtained in the required size and shape by commercial heat treatment. The possibility depends on the composition of the steel, on its hardenability, and on such external factors as the quenching medium and surface condition of the part.

Metallurgical factors

The tensile strength of low alloy steels can be estimated with sufficient accuracy for design purposes from the hardness. For fully hardened steels in the tensile strength range of 100,000 to 200,000 psi, yield strength, elongation and reduction of area can be estimated also. For example, yield strength will range from 80 to 95% of tensile strength. Above tensile strengths of 200,000 psi, the yield and tensile strengths are not so easily predicted from hardness values because of the effect of residual stresses.

Investigation of the properties of steels quenched to martensite shows that in fully hardened steels, one alloying element can be substituted for another, permitting steels to be selected on the basis of hardenability rather

TABLE 3—CLASSIFICATION OF LOW ALLOY STEELS ACCORDING TO STRENGTH[a]
(For an Average Impact Strength of 30 Ft-Lb)

Tensile Strength (after quenching in still oil), 1000 psi	Steels Meeting Requirements in Bars of Indicated Diameter			
	1 In.	2 In.	3 In.	4 In.
170–190	4140, 8840, 4340	4340	—	—
155–170	8640, 8740, 2340	4140, 9840	9840, 4340	4340
140–155	1340, 5140, 3140, 4640, 6140	8740	4140	9840
125–140	4040	1340, 8640, 3140, 4640, 2340	8740	4140
110–125	—	6140	8640, 4640, 2340	2340
95–110	—	5140, 4040	1340, 5140, 3140, 6140	1340, 8640, 8740, 3140, 4640, 6140
80–95	—	—	4040	5140, 4040

[a]Carbon content: 0.40%.
Source: *Crafts and Lamont.*

than composition. In incompletely hardened steels, if the degree of partial hardening is the same, substitution can also be employed. These conclusions have been verified by World War II experience with the NE steels which were successfully substituted for other steels containing strategically scarce elements. A grouping of steels according to hardenability is shown in Table 3.

The metallurgical considerations can be summarized briefly, as follows:

1. Optimum mechanical properties are obtained with steels having a tempered martensite structure.

2. All tempered martensite steels have nearly the same mechanical properties at a given hardness if the carbon content is the same.

3. In tempered martensitic steels of the same hardness, the lower the carbon content, the greater the ductility and toughness.

Therefore, if the designer specifies the shape of the part and its hardness, he fixes the other mechanical properties approximately. The problem then is to obtain in the part a tempered martensite structure free from internal stresses with the lowest practical carbon content.

Hardenability has been emphasized because it is the first criterion in the selection of a steel to be quenched and tempered—the treatment used for most of the engineering alloy steels. Although a minimum hardenability is required to obtain full hardening, high hardenability has no inherent value. Employing a steel having hardenabilty higher than required not only increases the cost of the part (because of the higher alloy content required), but also may lead to more difficulty in processing the part or to greater susceptibility to temper brittleness. Assuming the required minimum hardenability is available, other factors are involved in the selection of the most suitable steel. Among these are fabricating properties, forgeability, weldability, distortion during hardening and temper brittleness.

Size and shape factors

A major cause of internal strain is differential cooling during quenching, largely a function of the size and shape of the piece. The fundamental principle of good design for heat treatment is the development of shapes and sizes that will minimize temperature gradients during quenching. The greater the temperature difference between two points in a given part and the closer together these points are, the greater will be the internal strain and the poorer is the design.

Sharp angles and corners—Failure to insert radii or fillets at reentrant angles or corners is a major cause of heat treating problems, particularly in steels that must be water quenched to obtain the desired properties. It is difficult to achieve uniform cooling at these points because 1) heat is constantly being supplied from heavy adjoining sections, and 2) heat dissipation is slow because of the small cooling area. Consequently heavy internal strains are developed at points that will receive concentrated stressing in service. Even a small radius (Fig 8) will reduce or eliminate danger of cracking.

Abrupt section changes—Thin sections naturally cool faster than thick sections. Where the two are combined, transformation will occur at different rates and cause quenching stresses; the more abrupt the change in section, the more severe the internal stressing. To form a cooling gradient throughout the section and thus eliminate stress concentration, therefore, it is essential to employ large radii or to taper the part. Fig 9 shows a punch that would be difficult to heat treat properly and two possible variations to improve the part.

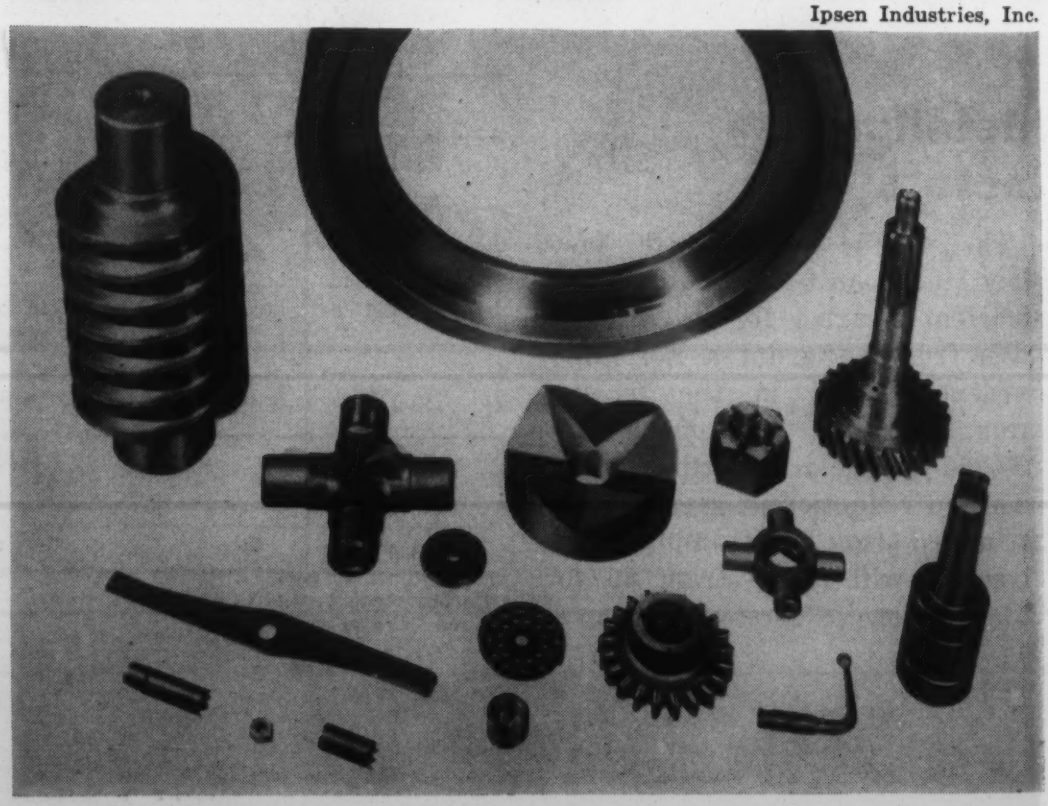
Blind holes—If possible, blind holes should be eliminated. Continuing the hole through the part improves uniformity in cooling, providing better stress balance, and eliminates the sharp corners at the bottom of the hole that would otherwise act as stress raisers. Junction of holes drilled into a part should also be avoided if possible; the holes are packed to reduce the tendency toward cracking, the intersection remains a stress raiser.

Heavy and light sections—In dies having light and heavy sections, uneven cooling may cause sufficient dimensional change to throw holes out of tolerance. Addition of holes to lighten the heavy section (see Fig 10) equalizes the cooling rate and minimizes distortion on quenching.

Inadequate wall thickness — Holes should not be drilled too close together nor placed so near cut-out sections that the remain-

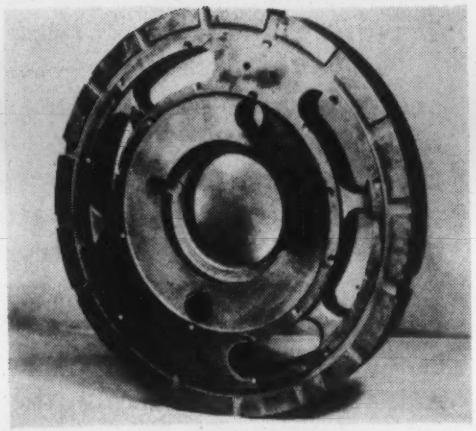
***Typical** heat treated parts of various designs.*

Ipsen Industries, Inc.



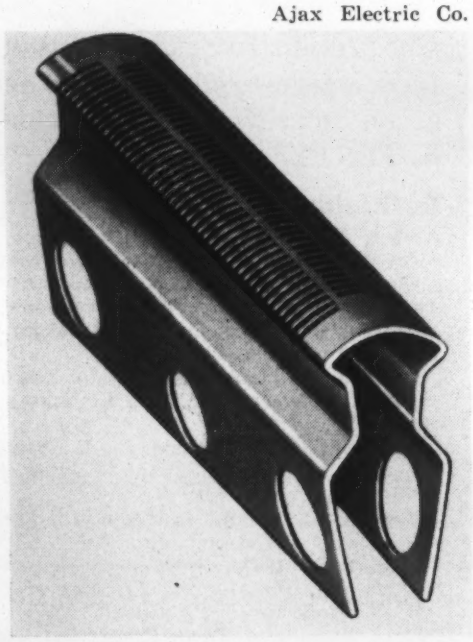
Martempering and Austempering: Some Typical Parts

Ajax Electric Co.



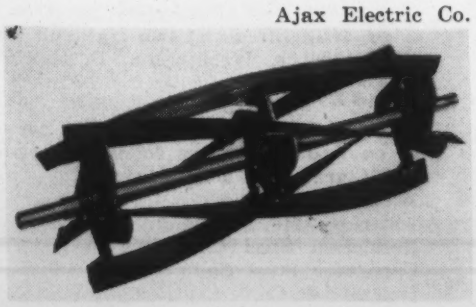
Part: *Valve plate.*
Steel: *Vasco V. D. (slightly higher hardenability than SAE 52100).*
Heat treatment: *Austenitized; martempered 5 min at 425 F; air cooled.*
Hardness: *Rockwell C62.*

Ajax Electric Co.



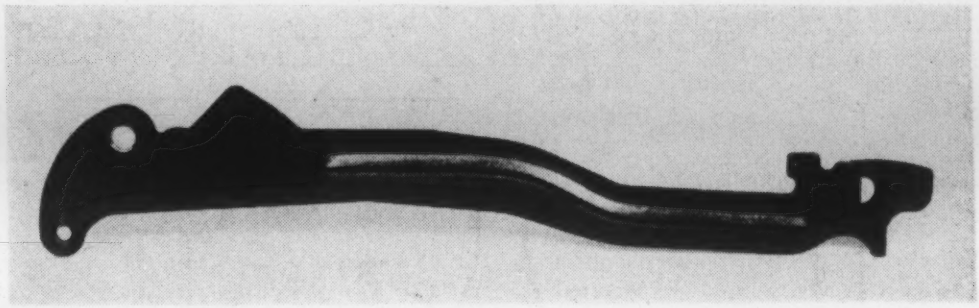
Part: *Electric shaver head (0.003 in. thick).*
Steel: *High carbon-vanadium.*
Heat treatment: *Austenitized in salt bath 5 min at 1550 F; austempered 1½ hr at 550 F; air cooled.*
Hardness: *Rockwell 15N 86-88.*

Ajax Electric Co.



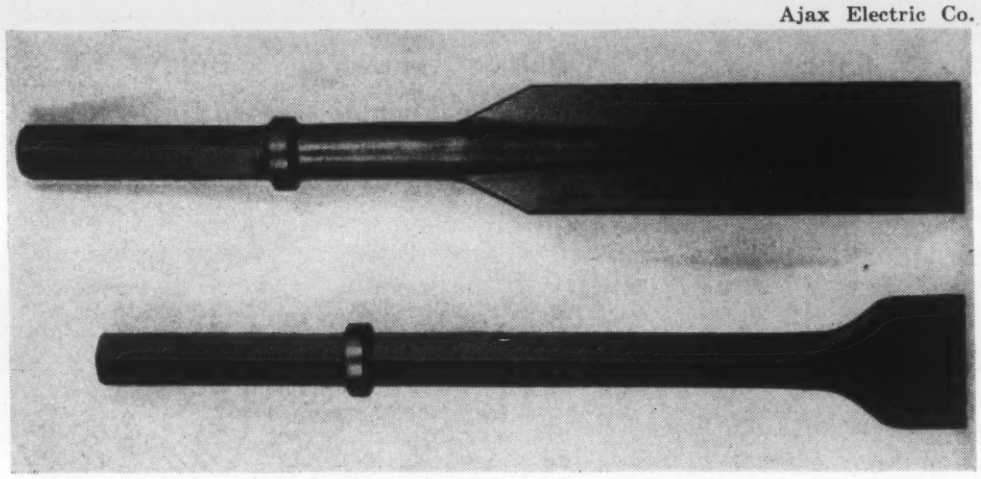
Part: *Lawn mower blades.*
Steel: *SAE 1065.*
Heat treatment: *Austenitized in salt bath 6 min at 1550 F; austempered 6 min at 475 F; air cooled.*
Hardness: *Rockwell C48-52.*

Ajax Electric Co.



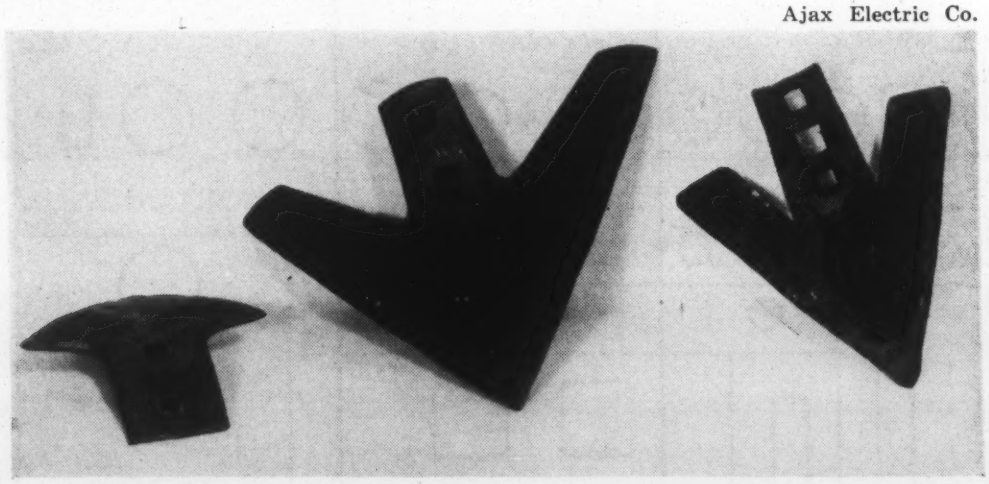
Part: *Typewriter bar.*
Steel: *SAE 1055.*
Heat treatment: *Austenitized in salt bath 4 min at 1450 F; austempered 5 min at 600 F. Tip end selectively tempered 4 min at 780 F.*
Hardness: *Tip, Rockwell C42-44; balance of bar, Rockwell C50-54.*

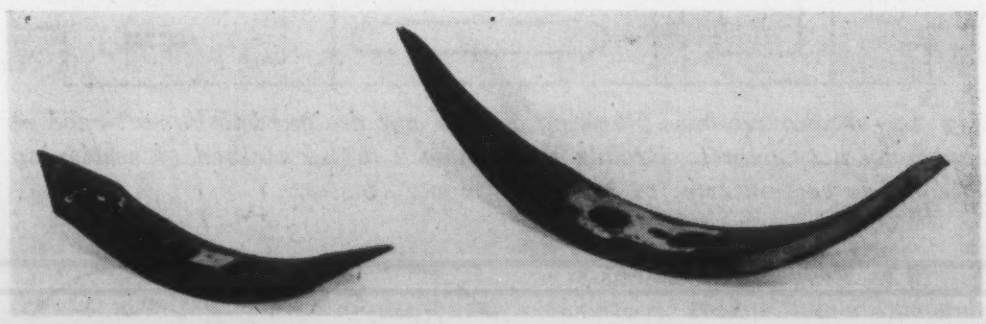
Ajax Electric Co.



Part: *Paving breaker tools.*
Heat treatment: *Austenitized in neutral salt at 1550 F; brine quenched; tempered in salt bath at 450 F.*
Hardness: *Rockwell C52-53.*

Ajax Electric Co.





Parts: *Tractor teeth and sweeps.*
Steel: *SAE 1080.*
Heat treatment: *Austenitized in salt bath at 1600 F; austempered in salt bath 5 min at 400 F; transferred to salt bath at 750 F and tempered 8 min.*
Hardness: *Rockwell C37-44.*

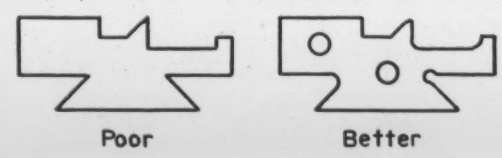


Fig 8—*Form tool: addition of lightening holes, fillets and radii make part more suitable for heat treatment.* (Palmer and Luerssen)

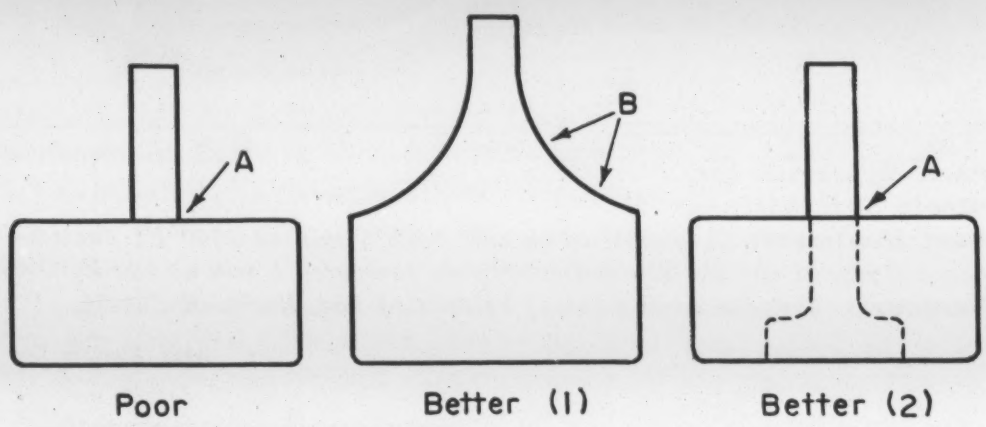


Fig 9—*Punch: abrupt directional change can be modified for better heat treatment by use of large radius (center). If sharp angle is required for proper functioning of the part, the punch can be made in two pieces (right).* (O'Brien)

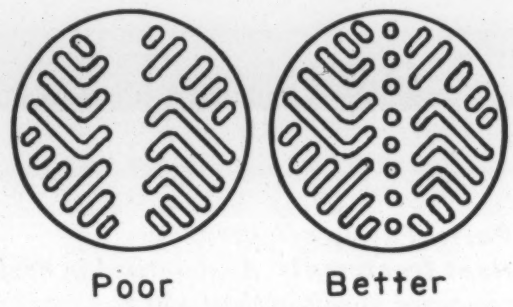


Fig 10—*Blanking die: Heavy center rib may cause warping in heat treatment. Drilling of lightening holes (right) equalizes the sections and reduces warpage.* (Palmer and Luerssen)

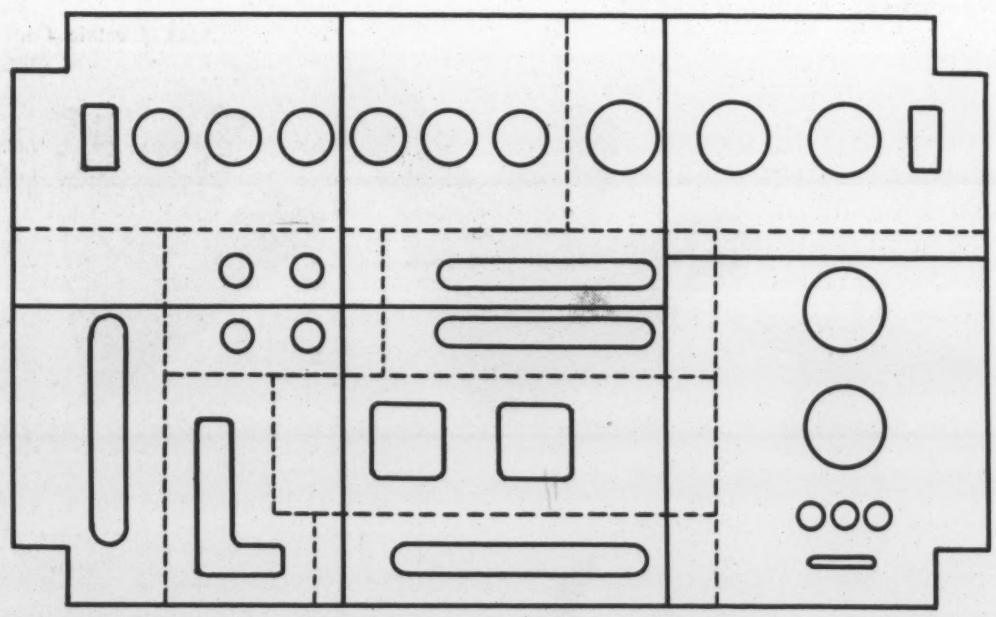


Fig 11—*Radio sub-base blanking die: It was designed to be sectioned as shown by heavy lines. Broken lines show a better method of sectioning to equalize section size for heat treatment.* (O'Brien)

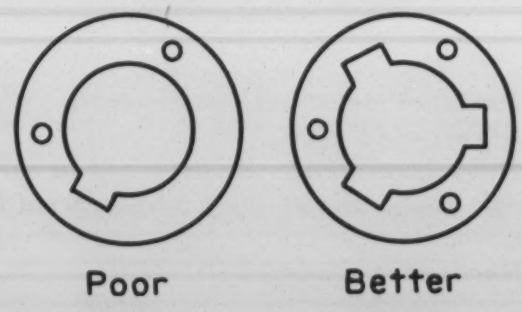


Fig 12—*Ring: Unbalanced section may warp in heat treatment. Securing uniform cooling by balancing the section (right) will minimize warping.* (O'Brien)

ing wall thickness is seriously reduced. Even packing such holes for heat treatment does not assure equalizing the cooling rate.

Unbalanced sections — Unbalanced sections result in non-uniform cooling during heat treatment and may cause serious volume changes. For example, large blanking dies are usually made in several sections to facilitate machining and permit design changes. A drawing of an actual radio sub-base blanking die is shown in Fig 11. The solid lines show the sections as designed; dotted lines show sections that would assure more uniform cooling during heat treatment.

Unequal stress — Addition of extra holes or keyways in circular sections, such as rings and sleeves, can be used to stress equalizers and prevent eccentricity resulting from a severe quench. An example of an improved design is shown in Fig 12.

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Acknowledgments

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Leeds & Northrup Co.
National Bureau of Standards
Republic Steel Corp.
Joseph T. Ryerson & Son, Inc.
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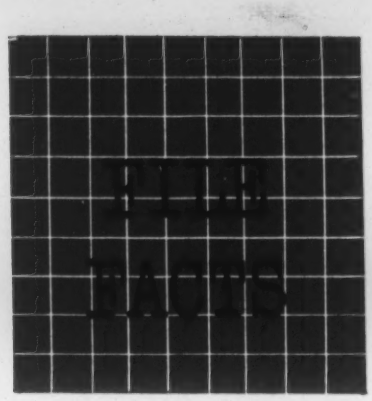


Sprayed Metal Coatings: Types, Properties and Uses

Type ➡	Aluminum	Babbitt A[a]	Brass (65:35)	Bronze AA[b]	Commercial Bronze	Manganese Bronze	Phosphor Bronze
Specific Gravity	2.41	6.67	7.45	7.06	7.57	7.26	7.68
Ult Ten Str, 1000 psi	19.5	—	12	29	11.5	12	18
Strain at Ult Str, %	0.23	—	0.45	0.46	0.42	0.46	0.35
Rockwell Hardness	H72	H58	B22	B78	B18	B27	B20
Shrinkage, in./in.	0.0068	—	0.009	0.0055	0.011	0.009	0.010
Spraying Speed, lb/hr	18	95	32	24	24	36	31
Spraying Efficiency, %[c]	89	69	81	77	82	79	85
Major Characteristics and Uses[d]	Good corrosion and heat resistance	Good bearing properties	Sprays fast. Fair machine finish	Hard, very wear resistant. Easily machined	Softest bronze. Fair machine finish	Excellent machine finish. Special uses only	Fair machine finish. Special uses only

[a]Lead-free, high tin alloy. [b]Aluminum-iron-bronze. [c]Percent of metal deposited.
[d]All metals have about the same shiny surface after spraying, but surfaces of the various metals differ after machining.

Type ➡	Tobin Bronze	Copper	Lead	Molybdenum	Monel	Nickel	18-8 Stainless
Specific Gravity	7.46	7.54	10.21	8.86	7.67	7.55	6.93
Ult Ten Str, psi	13	—	—	7.5	21	17.5	30
Strain at Ult Str, %	0.51	—	—	0.30	0.26	0.30	0.27
Rockwell Hardness	B27	B32	—	C38	B39	B49	B78
Shrinkage, in./in.	0.0104	—	—	0.003	0.009	0.008	0.012
Spraying Speed, lb/hr	36	29	80	8	17	18	21
Spraying Efficiency, %[c]	80	80	65	87	85	79	81
Major Characteristics and Uses[d]	General purpose. Fair machine finish	Electrical uses; brazing	Good corrosion resistance. X-ray shielding	Used as bonding coat. Excellent bearing properties	Good corrosion resistance. Good machine finish	Good corrosion resistance. Fair machine finish	High corrosion resistance. Good wearing properties

Type ➡	High Cr Stainless	Steel (LS)[e]	Steel (0.10% C)	Steel (0.25% C)	Steel (0.80% C)	Tin	Zinc
Specific Gravity	6.74	6.78	6.67	6.78	6.36	6.43	6.36
Ult Ten Str, psi	40	33.5	30	34.7	27.5	—	13
Strain at Ult Str, %	0.50	0.45	0.30	0.46	0.42	—	1.43
Rockwell Hardness	C29	C25	B89	B90	C36	—	H46
Shrinkage, in./in.	0.0018	0.002	0.008	0.006	0.0014	—	0.010
Spraying Speed, lb/hr	19	18	19	19	19	95	61
Spraying Efficiency, %[c]	81	87	87	87	87	73	66
Major Characteristics and Uses[d]	High hardness and wear resistance. Grind finish	Good mechanical and finishing properties	Simple bearing surfaces and press fits. Excellent machine finish	Harder and lower shrinkage than 0.10C. Excellent machine finish	Very hard and wear resistant. Good bearing properties. Grind finish	Good corrosion resistance, especially with foods	Good all-around corrosion resistance

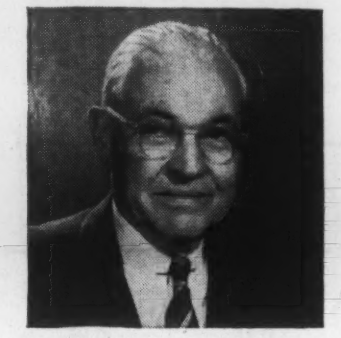
[e]Low shrinkage.

Courtesy of Metallizing Engineering Co.

For more information, circle No. 540

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY



Technical-ities

By John S. Davey

Selecting the right grade of nuts

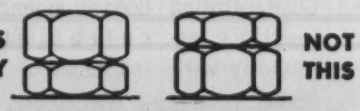
"Workhorse" among nuts is the standard "FINISHED" series. It gives good seating area; sufficient height to sustain high thread tension; enough wall thickness to control elastic nut dilation under load.

"HEAVY" nuts are wider than "Finished" nuts in *all* sizes by only ⅛" across flats. Thus, their value diminishes as size increases. Most effective in ½" to 1½" range, they satisfy applications involving excessive clearance holes, unusual loads, and certain boiler codes.

MATERIALS? The regular carbon nut steel (non heat treated). It makes nuts strong enough to pull bolts beyond yield point, lets threads distribute load to avoid stripping.

NUTS WITH "SPECIAL" FUNCTION

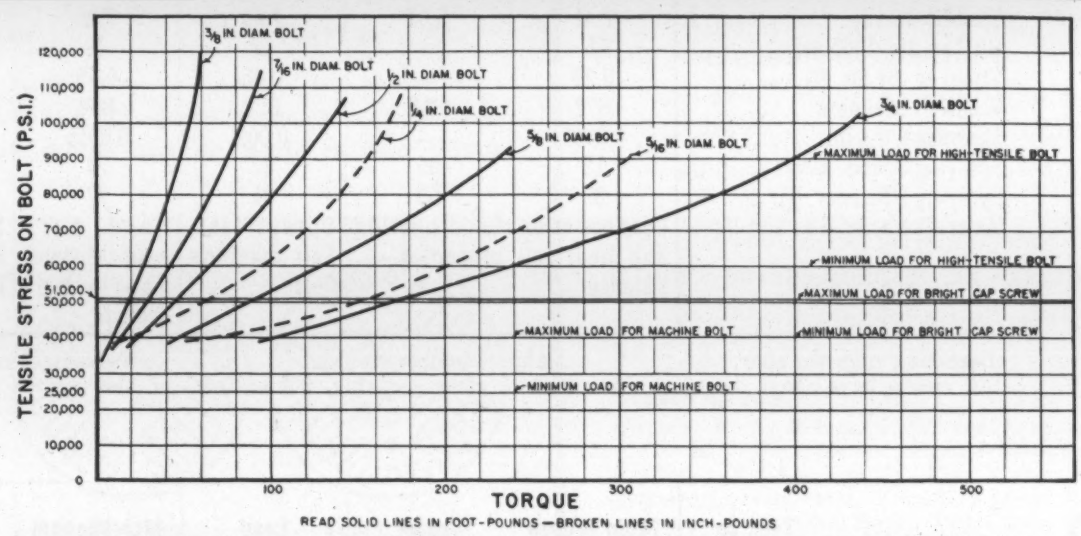
JAM NUTS are made for position locking. Use of two together forms a superior and economical locking device. When used to lock a regular nut, jam nut should be adjacent to work surface. Otherwise, the jam nut takes the load — a job it wasn't designed for.



Use a 2H NUT where high temperatures call for stability.

HIGH NUTS are used for shackle, U and tractor pad bolts. They're furnished only in fine threads, therefore, and hardened. More to be recommended are *coarse thread* finished nuts.

Tightening up fasteners tightens down on costs



These curves suggest torques for proper tightening of three grades of standard fasteners. Tightening to the upper limits delivers more of the holding power paid for, and assures stronger joints. Dropping below minimum values wastes fastener strength, invites loosening and failures. These curves are reproduced in RB&W Booklet DC-1.

It pays to go the limit in tightening bolts. Not only is it more economical, but safer too. For strength of a rigid connection depends on *residual tension* rather than on how strong the bolts are. Applying this fact can help avoid cost penalty.

EXAMPLE:

Blueprint specifies alloy bolts with strength of 145,000 psi. But assembly specification calls for tightening to what has been found an adequate pre-loading . . . only 30,000 psi. This wastes the fastener's capacity. It provides no more joint-strength than supplied by a *far more economical* RB&W bright cap screw tightened to same pre-load. It would be better to switch to the lower grade, or reduce size of the premium grade fastener.

REDUCING SIZE ALSO SAVES

A fastener's holding power is the same as its pre-load, or residual tension. So long as it permits tightening to the required pre-loading, the bolt can be small as possible.

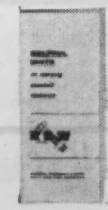
EXAMPLE:

Design requires fasteners with safe load capacity of 20,000 lbs. Bright cap screws of ¾" size will do it; but so will ⅝" RB&W High Strength Bolts — *at less cost*. Actually, for the same holding power as in $1.00 worth of high tensile fasteners, $1.50 worth of bright cap screws are required.

PRODUCTION BENEFITS

Along with direct savings, smaller bolts mean smaller holes to drill or tap. Smaller holes often allow reduction in size of fastened members.

Talk to an RB&W fastener expert at the design stage of your product. He can help you cut costs without cutting joint strength.



Meanwhile, send for helpful booklet DC-1. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

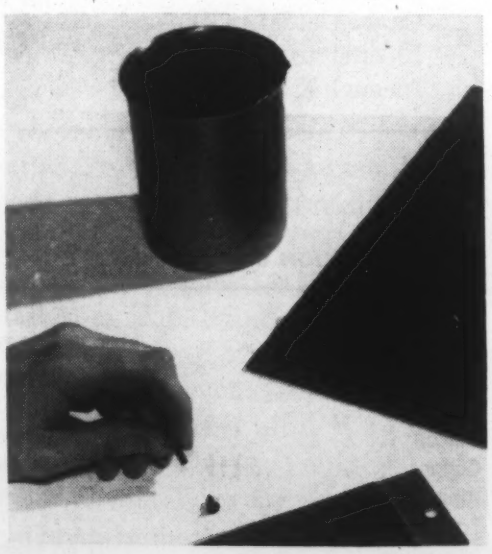
Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

For more information, turn to Reader Service card, circle No. 527

TFE Electroplates Are Smooth, Nonporous

■ Smooth, heavy, nonporous electrodeposited Teflon coatings are now possible by using a new aqueous colloidal dispersion of tetrafluoroethylene resin.

The dispersion, called Teflon 41-X and still in the experimental stage, was developed by E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington, Del. Du Pont says the dispersion contains 33 to 35% TFE in the form of hydrophobic, negatively charged particles.



***Electrodeposited TFE** covers beaker (upper left), test plates (right) and small wood screws (center) with a smooth, nonporous surface.*

How coating is applied

Parts are coated with Teflon 41-X by passing direct current through the dispersion, causing the negatively charged TFE particles to migrate toward the positive electrode (anode) by electrophoresis and the water phase to migrate toward the negative electrode (cathode).

The metallic anode is oxidized to form positive ions which immediately migrate toward the cathode. The metal cations contact negatively charged particles of TFE at the anode and, by neutralizing their charge, cause them to coagulate.

Since the ratio of charge to particle size for the metal ions is much greater than for the dispersed TFE particles, a considerable amount of TFE is electrodeposited when compared to the electrodeposition of copper and zinc. For instance, 20,000 to 50,000 gm of TFE are deposited per faraday (96,500 amp-sec) of electricity, whereas only 31.8 gm of copper and 32.7 gm of zinc are deposited per faraday.

PROPERTIES OF MOLDED TEFLON 41-X

Tensile Strength, psi	2200
Elongation, %	230
Modulus of Elasticity, psi	62,500
Notched Izod Impact Strength, ft-lb/in.	2.5
Thermal Conductivity, Btu/hr/sq ft/°F/in.	1.7
Durometer Hardness	D 55

Moldings too

Filled or fiber reinforced Teflon 41-X may be compression molded or extruded into sheets, gaskets and packings by first coagulating the dispersion, then drying and screening it. The dispersion may also be fabricated by paste molding. In paste molding, coagulated Teflon 41-X is dried to the consistency of stiff paste, molded into the desired shape, and dried completely in an oven, in a mold or on a hot plate.

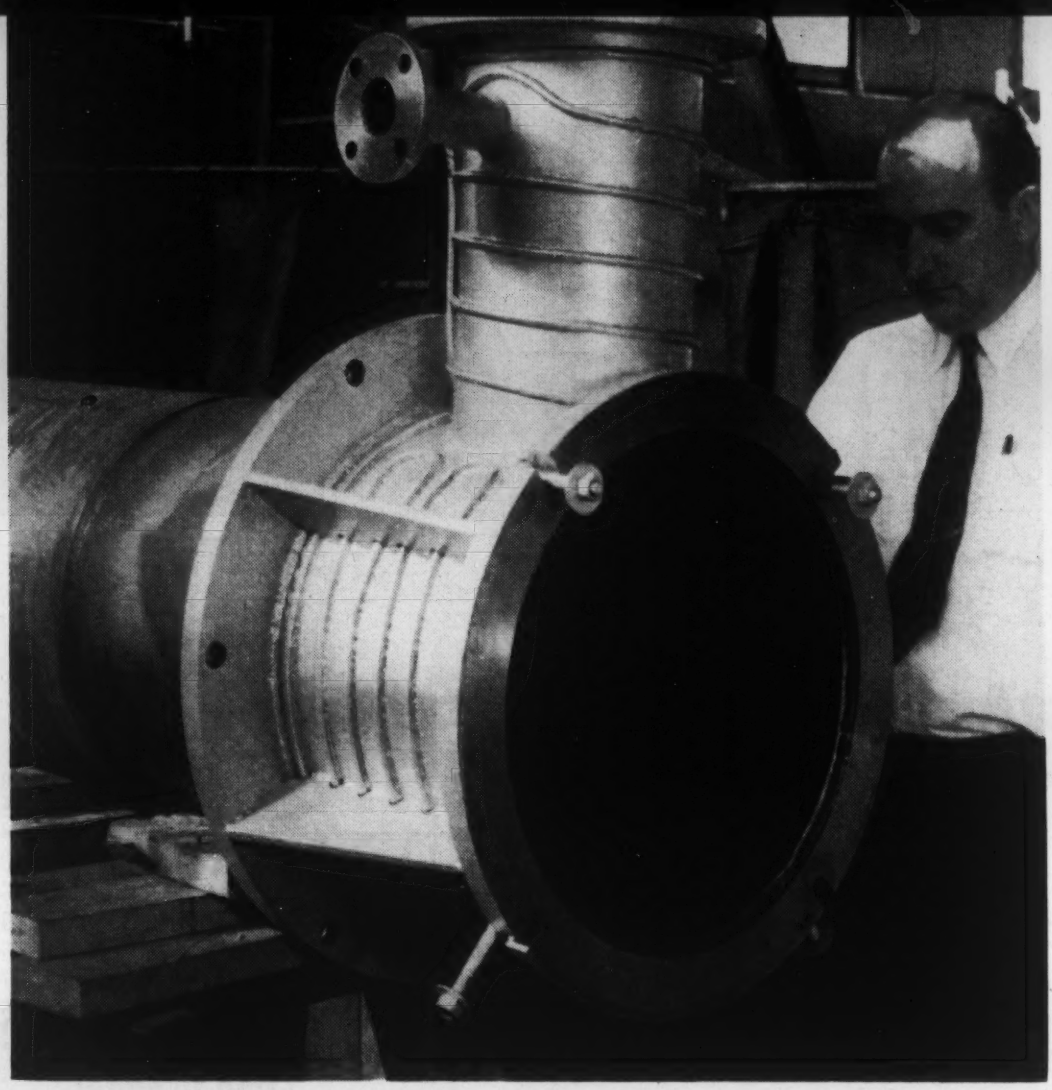
Du Pont says the material has potential use as a high temperature, corrosion resistant electrical insulation for motors, generators and transformers.

Inconel Welding Wire Joins Dissimilar Metals

■ An Inconel-base welding wire called Inco-Weld A has been developed by International Nickel Co., 67 Wall St., New York 5, for joining dissimilar metals. The producer says, "Inco-Weld A wire is the first welding material ever to be developed specifically for joining dissimilar metals—in fact it is capable of joining over 95% of all dissimilar metal combinations."

Properties and uses

Because the wire deposit has good impact resistance it is valuable as a material for overlay applications. Another important aspect of the welding wire is its use for joining 9% nickel steel. This steel has properties which make it especially suitable for such low temperature uses as vessels for storing liquid oxygen at –310 F or transporting liquid



Four steel flanges *on this high temperature vacuum retort were welded to the Inconel body with Inco-Weld A wire.*

methane at –235 F. Welds made with Inco-Weld A wire on 9% nickel steel are said to pass all requirements of section IX of the ASME Boiler and Pressure Vessel Code.

Deposits from the welding wire are said to have high strength, good machinability, good impact resistance at subzero temperatures, good high temperature properties and good corrosion resistance. Inco-Weld A wire deposits can be strengthened and hardened by stress relieving 2 hr at 1650 F, followed by aging 20 hr at 1300 F.

PROPERTIES OF INCO-WELD A WIRE DEPOSITS

Condition →	As Welded	Annealed[a]
Tensile Strength, psi	56,000	80,000
Yield Strength, psi	94,000	122,000
Elongation, %	42	12
Rockwell Hardness	R3	R27

[a]Annealed 2 hr at 1650 F, then aged 20 hr at 1300 F.

Availability

The new welding wire is available in 36-in. lengths in diameters of 1/16, 3/32, 1/8 and 5/32 in., and on spools in diameters of 0.035, 0.045 and 0.062 in.

What's new IN MATERIALS

Metals Welded with Inco-Weld A Wire

Type 304 stainless steel to monel
Type 304 stainless steel to carbon steel
Type 347 stainless steel to Inconel
Type 347 stainless steel to monel
Type 347 stainless steel to Incoloy
Type 405 stainless steel to Inconel
Type 410 stainless steel to monel
Carbon steel to monel
Carbon steel to Inconel
Inconel to Hastelloy C
Inconel X to Stellite 31

COMPOSITION OF INCO-WELD A (%)

Carbon	0.07 max
Manganese	2.00-2.75
Iron	8.00 max
Sulfur	0.01 max
Silicon	0.15 max
Copper	0.20 max
Aluminum	0.10 max
Titanium	2.75-3.35
Chromium	15.00-17.00
Nickel-Cobalt	71.72 68 37

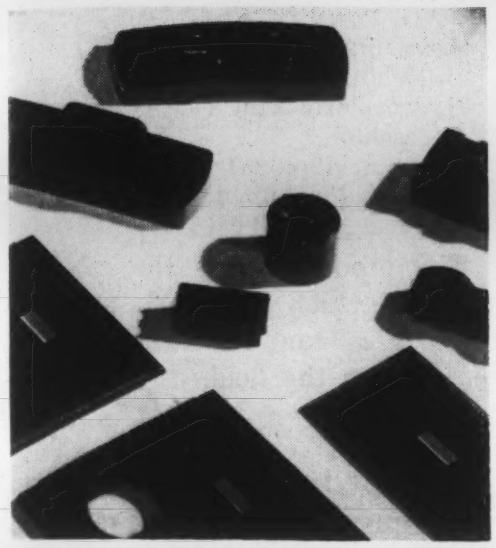
Woodflour-Filled Urea May Compete with Phenolic

■ Woodflour-filled urea, absent from the American scene since 1955, is now available from Barrett Div., Allied Chemical Corp., 40 Rector St., New York 6, in production lot quantities. Barrett has just completed construction of a plant at Edgewater, N. J. which, it says, is ". . . the only plant in the country producing this thermosetting plastic."

The new and improved material is expected to find use in closures, wiring devices, radio cabinets, toys, buttons, light sockets, circuit breakers, circuit boxes and electrical switches.

Properties and cost

Roughly equivalent to phenolic in price (19¢ per lb vs 20¢ for phenolic) the woodflour-filled urea,



***Electrical parts** made of Barrett's woodflour-filled urea have good arc resistance.*

marketed under the Plaskon trade name, produces rigid moldings with hard, durable surfaces that are said to be unaffected by common organic solvents, soaps, borax, oils and greases. Barrett says the filled urea surpasses phenolic compounds in colorfastness and arc resistance (80 to 100 sec vs 0 to 10 sec for phenolic), but has greater mold shrinkage and lower heat resistance.

Woodflour-filled urea differs from the more expensive (33¢ per lb) alpha cellulose urea molding compound in that its filler is finely ground woodflour rather than bleached wood pulp. Physical characteristics of the woodflour-filled compound are comparable to those of alpha cellulose-filled urea, but the woodflour-filled compound does not match the color translucency or color range of alpha cellulose-filled urea.

The improved urea compound is presently available in two shades of brown and black, and plans are underway to provide other colors.

PROPERTIES OF WOODFLOUR-FILLED UREA

PHYSICAL PROPERTIES	
Specific Gravity	1.45-1.49
Max Heat Resistance, F	170
Heat Distortion Point, F	270-280
Flammability, in./in.	Self-extinguishing
Water Absorption (24 hr at 77 F), %	0.80-1.10
MECHANICAL PROPERTIES	
Izod Impact Strength, ft-lb/in.	0.25-0.35
Compressive Strength, psi	25,000-35,000
Flexural Strength, psi	7,500-12,000
ELECTRICAL PROPERTIES	
Arc Resistance, sec	80-100
Dielectric Strength, v/mil	
Short-Time	300-400
Step-by-Step	250-300
Dielectric Constant (60 cps)	7.0-9.5
Dissipation Factor (60 cps)	0.035-0.040
Loss Factor (60 cps)	0.24-0.38

New coloring process turns out . . .

Colored Metal Sheet with Good Formability

■ A new metal coloring process called Permyron shows promise of producing colored ferrous and nonferrous metals that can be severely formed after coloring without impairing the surface. Developed by Electro Metallurgical Co., Div. of Union Carbide Corp., Niagara Falls, N. Y., the process produces only black-colored metals at present but will ultimately be available for a range of colors. Electro Metallurgical Co. says it will license the process to metal fabricators on a nonexclusive basis.

Basically, the Permyron process involves applying the proper pigment in a suitable vehicle to specially prepared metal surfaces by such methods as spraying or roller coating, then processing under controlled conditions of temperature and atmosphere.

Plain or textured, Permyron colored metals look promising for a variety of applications, including toys, signs, sporting goods, photographic equipment, appliances, household furniture, automobile and aircraft parts, and barbed wire.

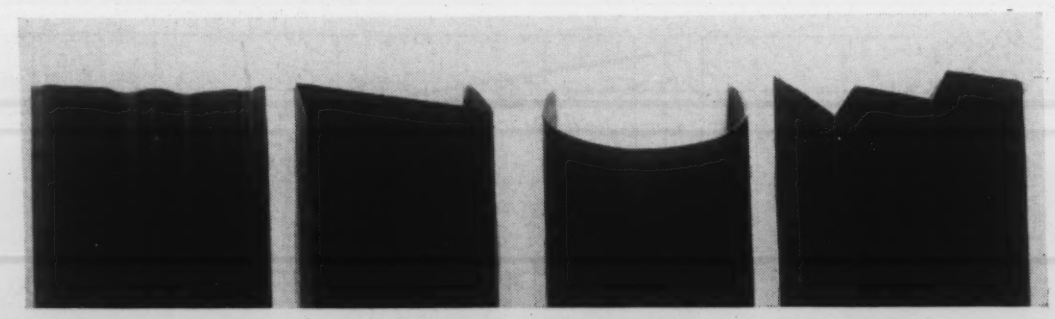
Properties

Ductility — Simple bend tests conducted on a black-colored stainless steel sheet show that the colored surface remains intact when bent 180 deg. Erichsen cup tests show the colored surface remains intact when stressed to an Erichsen impression of 7-mm depth. Typical tensile tests indicate that there is no visible effect on the coloring up to about 50% elongation of the specimen.

Weather resistance — A slight color change was noticed in a Permyron colored sample after aging 200 hr in a weatherometer, but no further change occurred after aging 200 to 500 hr. Weatherometer tests were conducted by exposing Permyron colored samples to ultraviolet light at 140 F and spraying them with tap water for 18 min every 2 hr.

Abrasion resistance—An abrasion test, conducted by rotating a stiff, weighted brush with Bon Ami as the abrasive on a sample, shows the sample remains intact after 100,000 strokes.

Thermal shock resistance — No



***Black-colored metal,** colored by Electro Metallurgical Co.'s Permyron process, can be severely bent without damage to the coloring.*

effect on coloring was noted after heating a sample to 95 F, then plunging it into ice water.

Water resistance — Water and high humidity have no effect on the coloring of a black Permyron sample. Tests were conducted by soaking a sample in distilled water at 120 F for 500 hr and by aging another sample in 100% RH at 120 F for an extended period.

Chemical resistance — These fluids do not affect Permyron colored stainless steel at 120 F (aged ½ hr):

Ammonium hydroxide (5%)
Di-isobutyl ketone
Hydrochloric acid (30%)
Kerosene
Nitric acid (40%)
Saturated sodium phosphate
Sulfuric acid (30%)

The producer says the colored surface, which has a Moh hardness of 5, can be satisfactorily repaired in the field.

Here are some new data on . . .

Columbium-Base Alloys for High Temperature Use

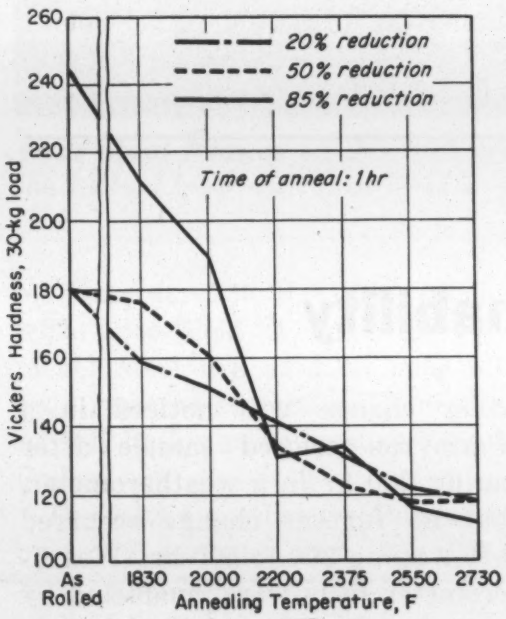


***Fig 1**—How hardness varies with annealing temperature in commercially pure columbium bar.*

■ Recently released results of a research program indicate that columbium-base alloys are superior to previously used metals such as molybdenum for structural applications at temperatures over 1800 F.

According to Wright Air Development Center's *Technical Report* 57-344, edited by Richard T. Begley, Aviation Gas Turbine Div., Westinghouse Electric Corp., the research was directed primarily toward a study of the properties of columbium metal in order to provide the background data necessary for a systematic investigation of columbium-base alloys. The work includes studies of recrystallization behavior, creep-rupture properties, oxidation behavior and weldability.

The columbium metal used in most of the work was obtained from Fansteel Metallurgical Corp. in the form of powder and vacuum sintered bar. The chemical analysis of the material is listed in Table 1 on p 148.

Recrystallization behavior

Strain hardening is an effective and well-known method of increas-

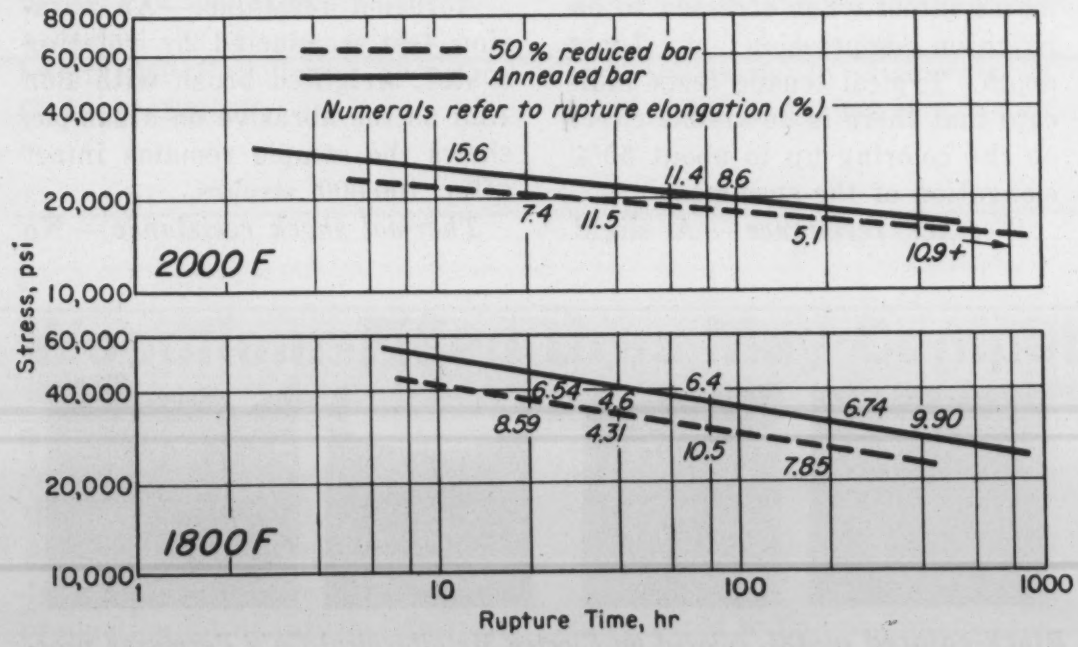


***Fig 2**—Rupture strength of commercially pure columbium.*

MORE WHAT'S NEW

Gold coatings, paints..... 150
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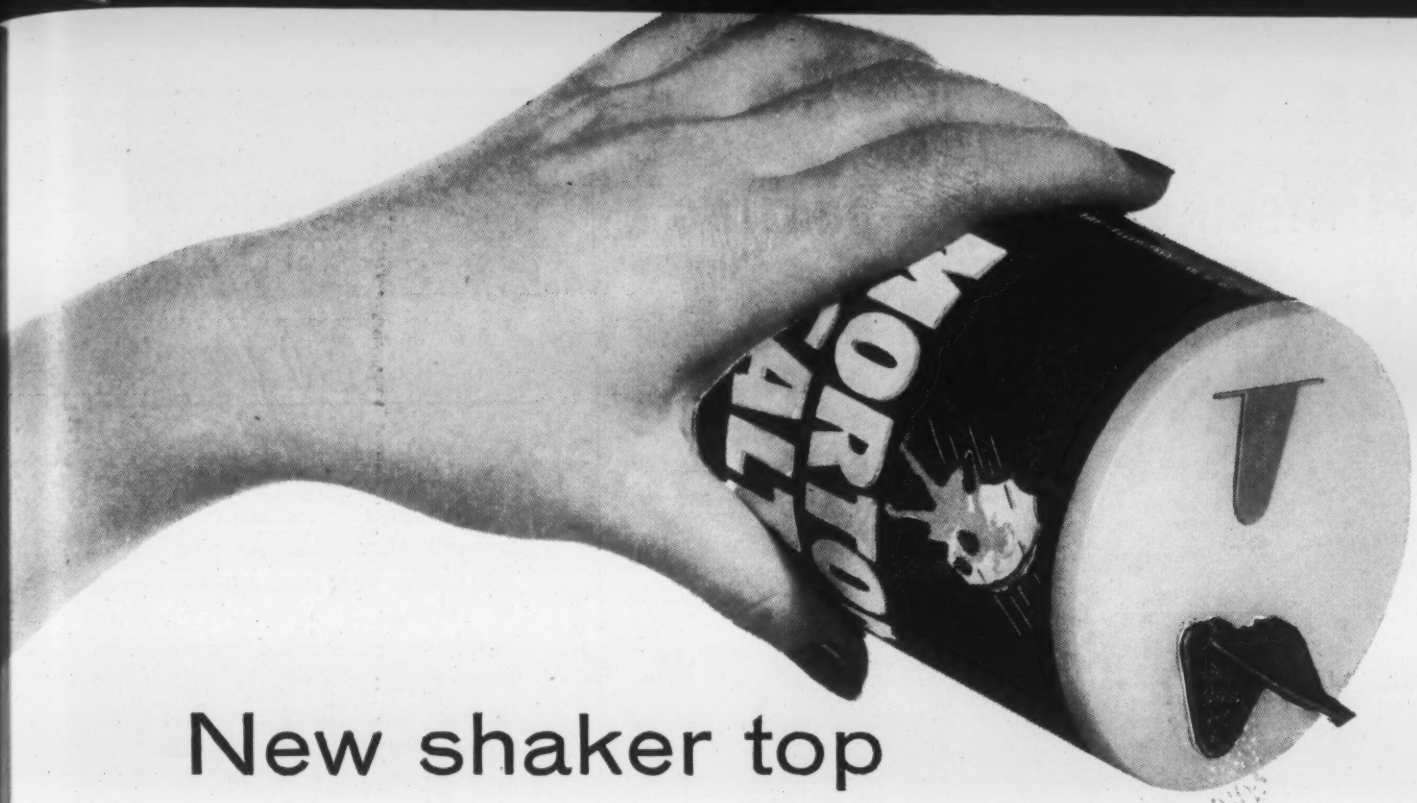
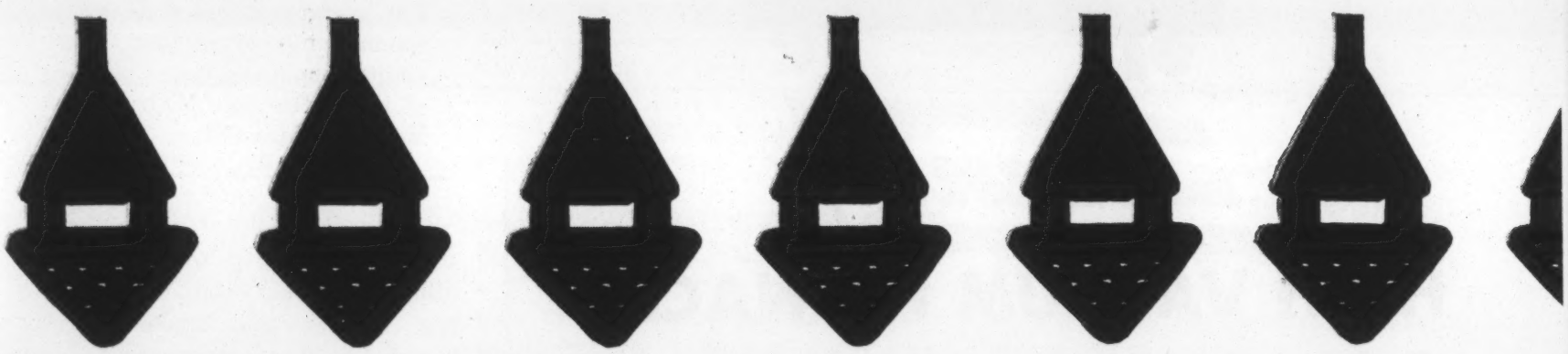


New shaker top of **TENITE POLYETHYLENE** sells more salt for Morton



A simple packaging improvement that lets a housewife *sprinkle* salt right from the container has given Morton Salt Company an important sales lead in market after market.

The new patented shaker device, fitted into the top of the salt package, consists of sprinkler and self-hinged sprinkler-cover, molded all in one piece. The material is Tenite Polyethylene in a formulation which affords just the right stiffness to keep the cover erect when open, and ample toughness to guard against breaks in the hinges.

The desired blue color is achieved by using a Tenite Polyethylene color concentrate, added in fixed proportion during the molding process. By this means, Morton secures uniform color results while employing several different molders.

In Tenite Polyethylene, the Morton Salt Company also found the more general characteristics needed to make the idea practical. First of these were low material cost and ease of fabrication. Important, too, were resistance to corrosion by salt or water; moldability that would permit one-piece design; and resilience that would make possible a tight friction-fit between cover and sprinkler.

The shaker top is a good example of how the many useful properties of versatile Tenite Polyethylene can satisfy design needs. If you have a design—or even just an idea—that could be given effective reality in polyethylene, why not look into the possibilities offered by Eastman's wide range of formulations.

For more information on Tenite Polyethylene and advice about its use, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Shaker top molded for Morton Salt Company, Chicago 3, Ill.,
by: Korris Products, Inc., Lyons, Ill.
Victory Manufacturing Co., Chicago 12, Ill.
Northwest Molded Products Corp., Skokie, Ill.
Ken Hagen Co., Shelburn, Ind.
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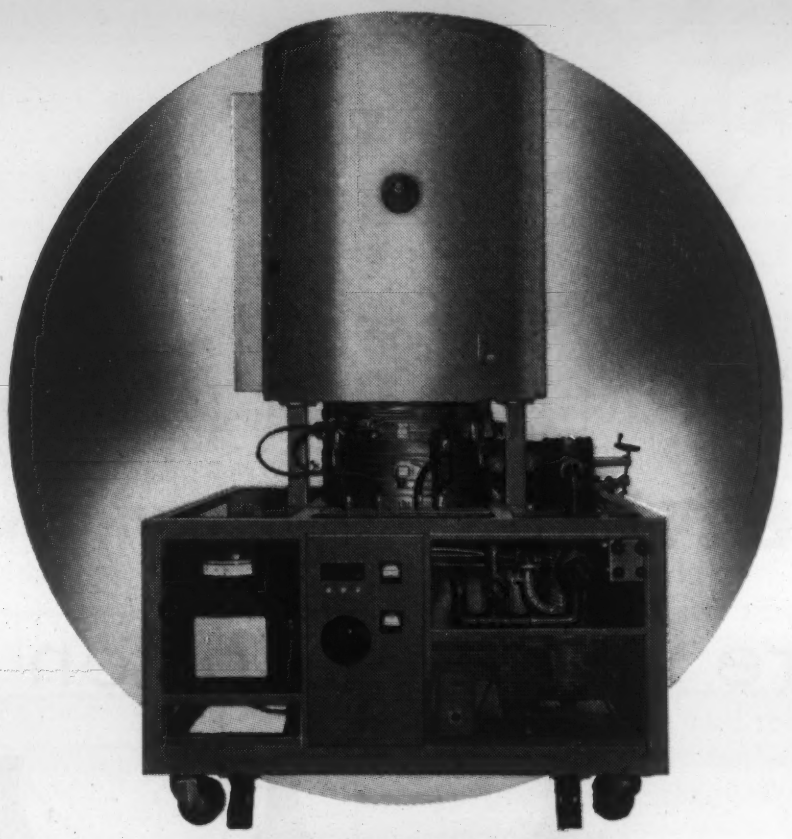

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What's new IN MATERIALS

Why Columbium?

Although a number of high temperature alloys are now available, only columbium seems to possess a satisfactory combination of high temperature properties: 1) it is generally ductile and easy to work at room temperature; 2) its density—0.4 lb per cu in.—is about the same as that of currently used nickel and cobalt-base alloys; and 3) although it is not particularly strong at room temperature, its high temperature strength is quite good.

This article covers some new data recently made available on the properties of columbium. For a comprehensive review of columbium's properties, availability, applications and methods of production, see MATERIALS & METHODS, May '57, p 131.

ing the strength of metals and alloys but recrystallization limits the temperature at which the beneficial effects of strain hardening are maintained. The recrystallization behavior of columbium was studied by means of hardness determinations as well as metallographic and x-ray examination. Fig 1 shows the Vickers hardness of columbium with various amounts of cold work plotted as a function of annealing temperature for 1-hr anneals.

Examination of the x-ray data indicates that columbium with a 20% reduction in area is completely recrystallized at about 2300-2500 F; with a 50% reduction, it is recrystallized at about 2000-2200 F; and with an 85% reduction, at about 2000-2200 F. These results are in fairly good agreement with the curves in Fig 1 on p 144.

Creep-rupture

The 100-hr creep-rupture strength of commercial columbium tested in vacuum at 1800 F and 2000 F was found to be signifi-

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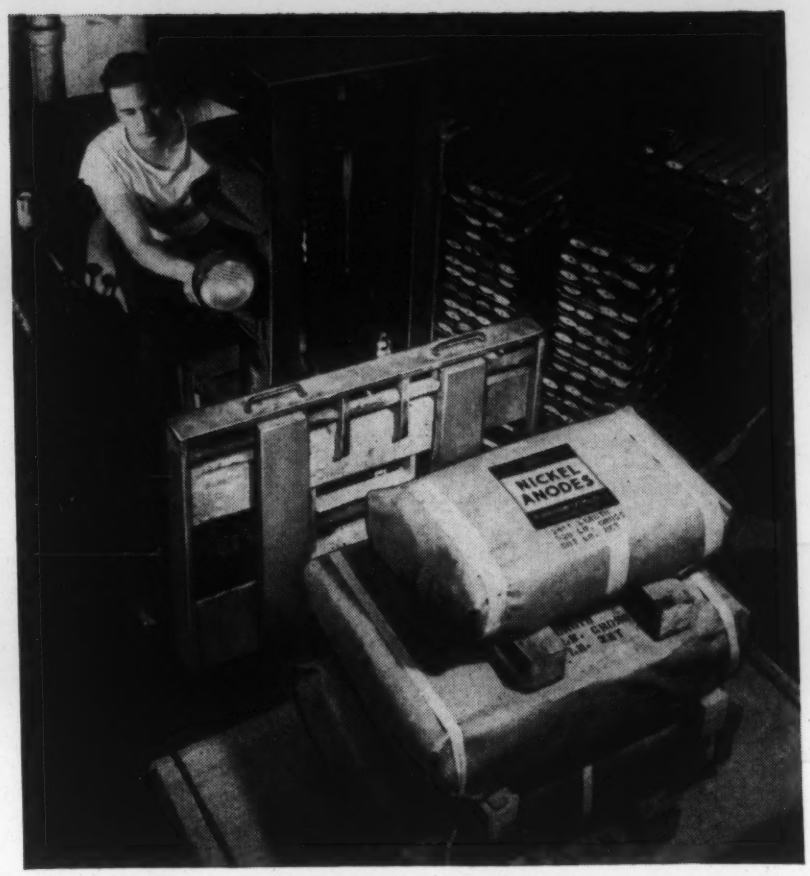

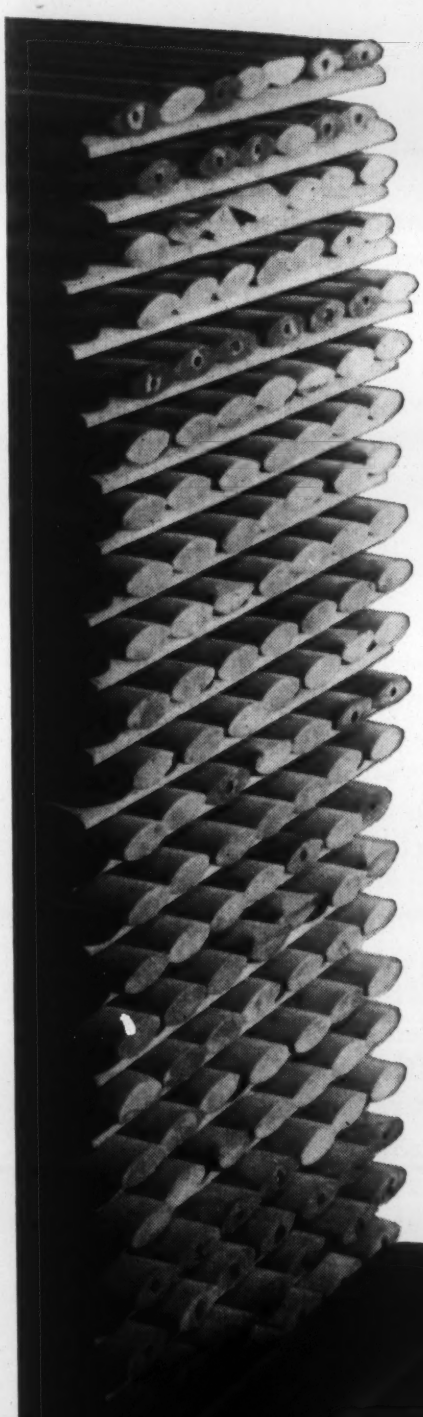

HARSHAW XXX CAST CARBON NICKEL ANODES are oval 1½'' x 3'' in cross section and are available in any length desired. Weight is approximately 1.1 lbs. per linear inch. They are normally used in dull, semi bright and bright nickel plating baths where the pH is 4.5 or lower.

HARSHAW ROLLED OVAL CARBONIZED NICKEL ANODES are 1¼'' x 3'' in cross section and are available in any length desired. Weight is approximately 1 lb. per linear inch. They are generally used in dull, semi bright and bright nickel plating baths where the pH is 4.5 or lower.

HARSHAW ROLLED OVAL DEPOLARIZED NICKEL ANODES have the same cross section and weight as the rolled oval carbonized nickel anode and are also available in any length desired. These anodes are generally used in nickel plating baths where the pH is 4.0 or higher; they are extremely suitable for such use, as they will corrode well over a wide range of operating conditions.

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Harshaw anodes are shipped in compact packages which feature built-in skids and facilitate quick handling by mechanical or hand trucks. The packages stack easily and quickly. Also, no deposits or returnables are involved with this type of packaging.

Harshaw Nickel Anodes are readily available and prompt shipment of any quantity will be made upon receipt of your order.

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cantly higher than that of pure molybdenum (see Table 2). The high strength is attributed to the presence of zirconium plus contamination by small amounts of oxygen and/or nitrogen. Ductility at fracture is fairly good—about 5% or more.

Rupture strengths and ductility values of columbium from 1 to 1000 hr at both 1800 F and 2000 F are given in Fig 2 on p 144.

Oxidation behavior

The oxidation behavior of columbium in 0.1 atm of oxygen was investigated in the range 650-1300 F. At 700 F, oxidation follows a parabolic rate law, and no evidence of a transition is observed in the rate of oxidation even after 6 hr. At 750 F, the oxide is initially protective, but after 4½ hr a transition to a linear rate is observed. As the temperature is increased, the initial stage of the reaction becomes shorter, and at 925 F the parabolic rate is no longer observed. Between 500 and 1160 F the rate of oxidation is independent of temperature.

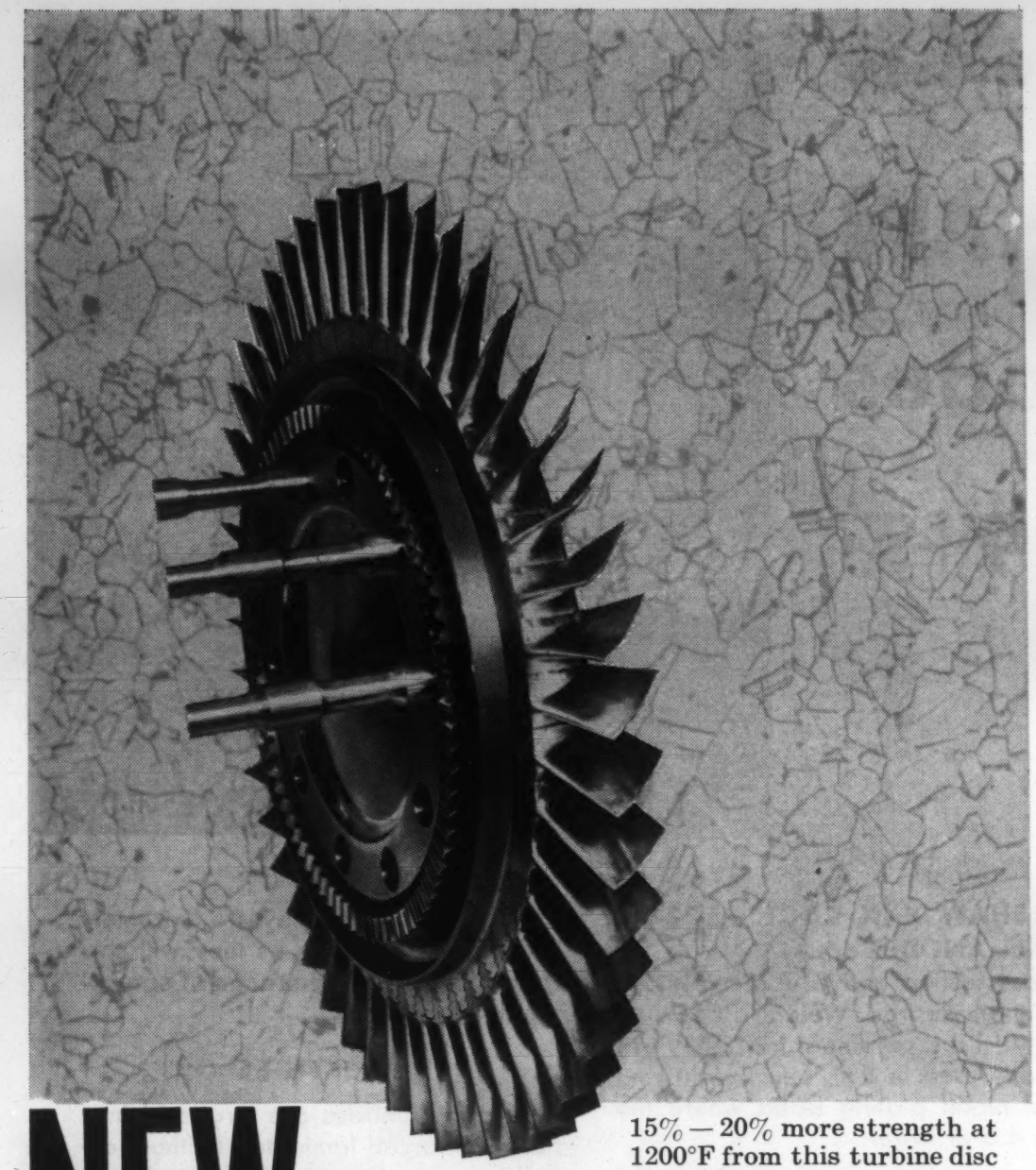
According to the report, a relationship appears to exist between the spalling of the oxide at elevated temperatures and the transition from a parabolic to a linear rate law.

Weldability

Columbium may be welded without difficulty in an argon atmosphere. Contamination of the welding atmosphere with 0.63% oxygen is not extremely harmful

TABLE 1—COMPOSITION OF COLUMBIUM

Form →	Vacuum Sintered Bar	Powder	Arc-Cast
Tantalum...	0.14-0.16	0.15	0.689
Iron.....	0.009-0.016	0.005	—
Titanium....	0.004-0.014	0.005	0.01
Zirconium...	0.60-0.70	0.81	0.05
Carbon.....	0.008-0.016	0.19	0.001
Oxygen.....	0.04-0.01	1.2	0.06
Nitrogen....	0.025-0.03	0.19	0.018



15% — 20% more strength at 1200°F from this turbine disc gives added dependability.

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W-545 is an improved high-strength and high-temperature material with low strategic alloy content for ease of fabrication. Critical high-temperature parts can be made from this material to have excellent strength-to-weight ratios and can be used at temperatures up to 1350°F.

W-545 will withstand higher stress levels than current disc alloys, at the same operating temperatures . . . or it will withstand equivalent stress characteristics at 100°F higher operating temperatures. W-545 is outstanding for turbine discs, couplings, shafts, valve stems, bolts, etc., in the missile, gas and steam turbine fields. W-545's nonmagnetic and high yield strength characteristics make it very desirable for low-temperature uses, such as retaining rings and wedges in electrical apparatus.

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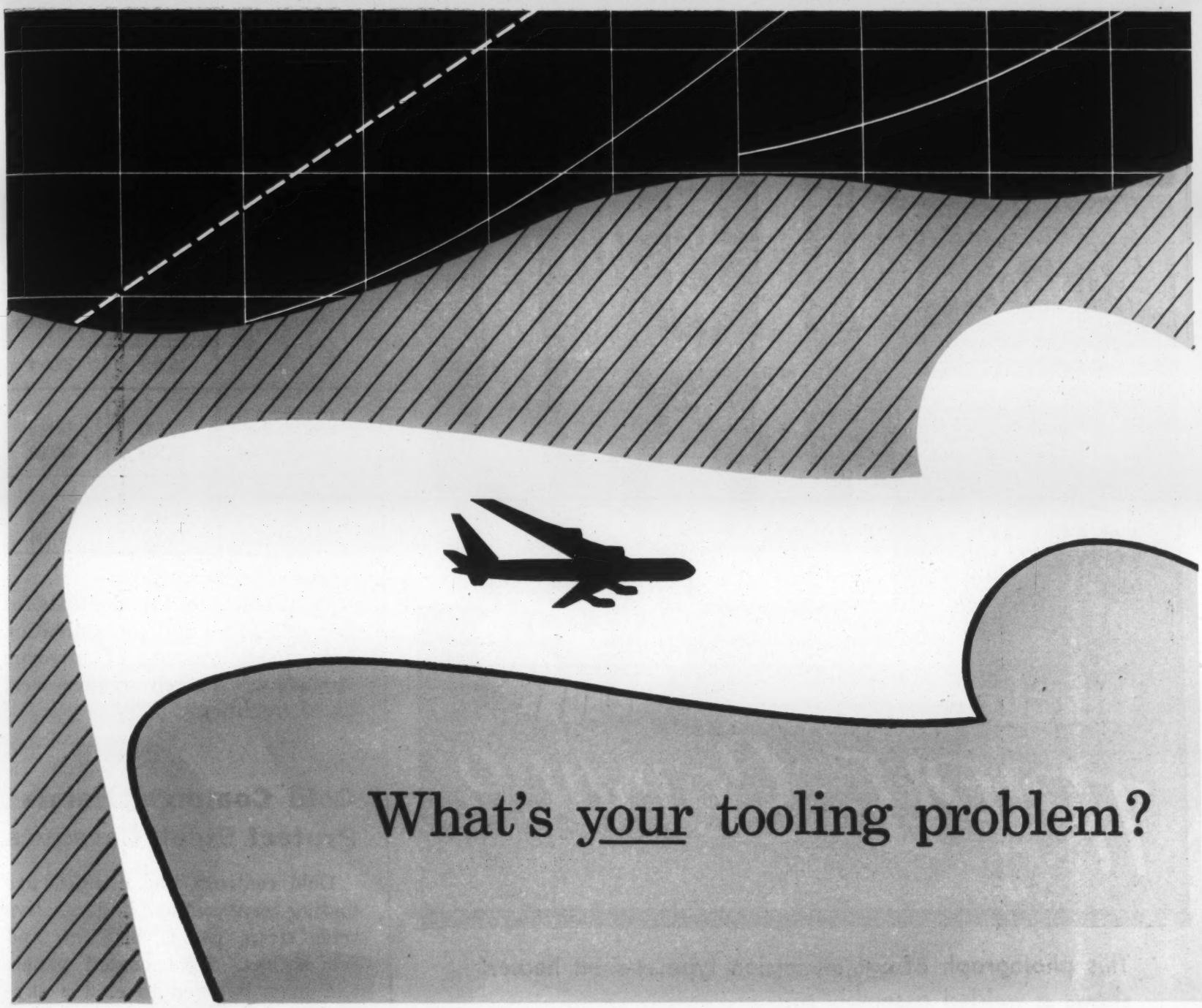

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DURALOY

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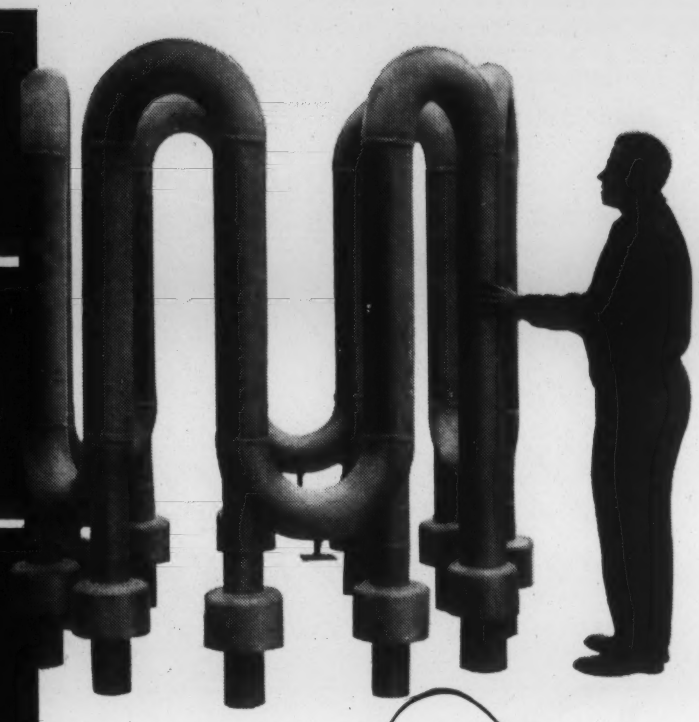

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TABLE 2—RUPTURE STRENGTH—COLUMBIUM VS MOLYBDENUM

	100-Hr Rupture Strength, psi	
	1800 F	2000 F
Columbium		
Cold Worked...	28,500	18,500
Recrystallized..	33,500	20,000
Molybdenum		
Cold Worked...	22,000	13,000
Recrystallized..	13,000	9,000

with respect to the ductility of the weld metal, but contamination with small amounts of nitrogen appears to severely reduce weld metal ductility.

Gold Coatings, Paints Protect Steel, Ceramics

Gold coatings and enamels are finding increased use in decorative trim, signs, panels, emblems and trademarks. Gold coated panels will even be used to clad a skyscraper now under construction in New York City. Recent developments in these coatings and enamels include: an antique gold porcelain enamel; a 22-carat gold speckled enamel; a method of applying 22-carat gold permanently to porcelain enamel, ceramics and stainless steel; and an electroless gold plating process. (Information on another electroless gold plating process may be found in the Oct '57 issue of MATERIALS IN DESIGN ENGINEERING, p 183.)

1. Electroless gold coating

Metal Processing Co., Inc., 41 Canfield Rd., Cedar Grove, N. J., has introduced an electroless gold

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What's new IN MATERIALS

plating process called Lustralloy-G that is designed especially for plating nickel surfaces. The company says gold deposition is continuous at a rate of about 0.0324 gm per in. per hr. The coating is said to be tarnish resistant and as resistant to salt spray as gold electroplates.

2. Gold panels

An antique gold, porcelain enameled panel has been developed by Caloric Appliance Corp., Topton, Pa., for curtain wall construction. The producer says the gold enamel is textured to give a rich, distinctive finish.

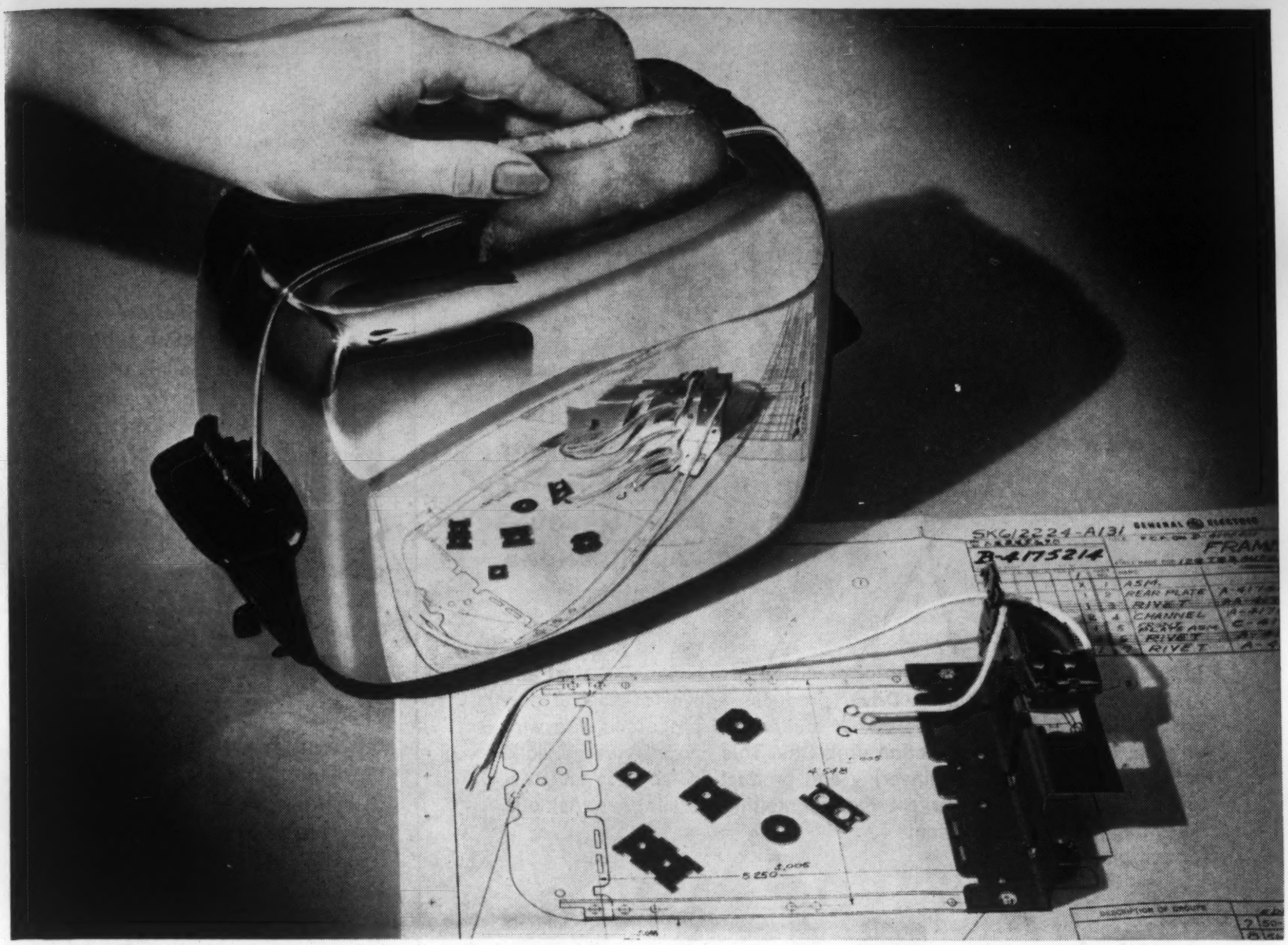
Another gold enameled panel, introduced recently by Ingram-Richardson Mfg. Co., Beaver Falls, Pa., is coated with a 22-carat gold speckeled enamel that is said to be permanently fused to the metal surface. The gold coated panel is recommended for signs and trim.

3. Gold coating

What is described as an "economical method" of applying 22-carat gold coatings on ceramics, porcelain enamel and stainless steel has been developed by Hanovia Chemical & Mfg. Co., Ceramic Div., 1 West Central Ave., East Newark, N. J. The coatings are applied to various materials by a "heat treatment method" that covers an area of between 50 and 60 sq ft with 22-carat gold at a cost of $17. According to the producer, panels to be used in a skyscraper now under construction in New York City will be gold coated with the new process. Other uses for the 22-carat gold coating include lettering, trim and store fronts.

New Teflon Products: Tubing, Film, Tapes

A number of new Teflon products have been introduced during the last few months; they range from cementable tapes and sheets to porous filter cups, films, copper

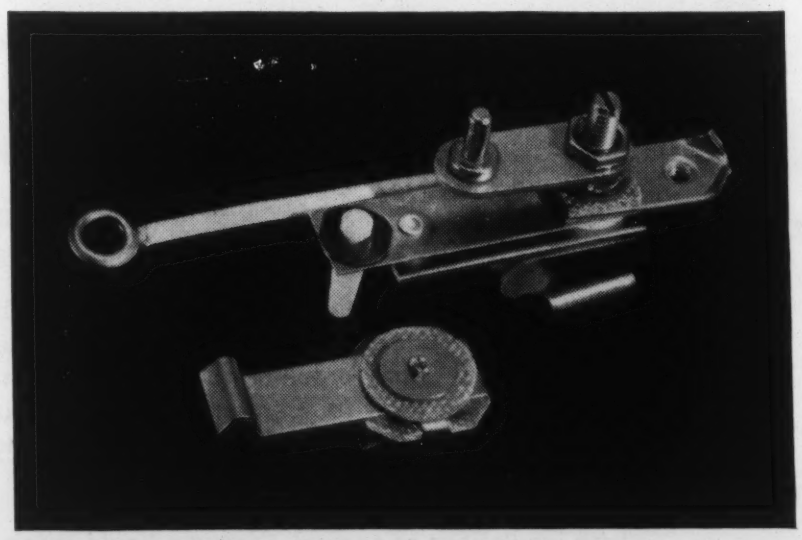


6 Taylor-Fabricated Laminated Plastic Insulators Protect Control Elements of GE Automatic Toaster

These insulators for the pop-up mechanism, color control unit, and heating element in the General Electric Automatic Toaster are made of continuous filament woven glass fabric with melamine resin bond. This Taylor Fibre Co. material was selected for its ability to withstand the temperatures encountered in the toasting operation, its excellent arc resistance and mechanical strength, and its cost, which is lower than that of the mica insulators formerly used.

Another factor in the decision was the capacity of Taylor Fibre Co. to produce the fabricated parts to specification, and in the large quantities required, at reasonable cost.

You, too, may have applications which can utilize the combination of physical, mechanical and electrical properties found only in laminated plastics. Our application engineers will be glad to discuss them with you, offer engineering assistance, and recommend a Taylor grade that will fit your specific requirements. Our plants at Norristown, Pa., and La Verne, Calif., are both fully equipped for fast supply of basic materials and finished parts. Write us for detailed information or to arrange for a Taylor Fibre man to call on you. TAYLOR FIBRE Co., Norristown 41, Pa.



Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

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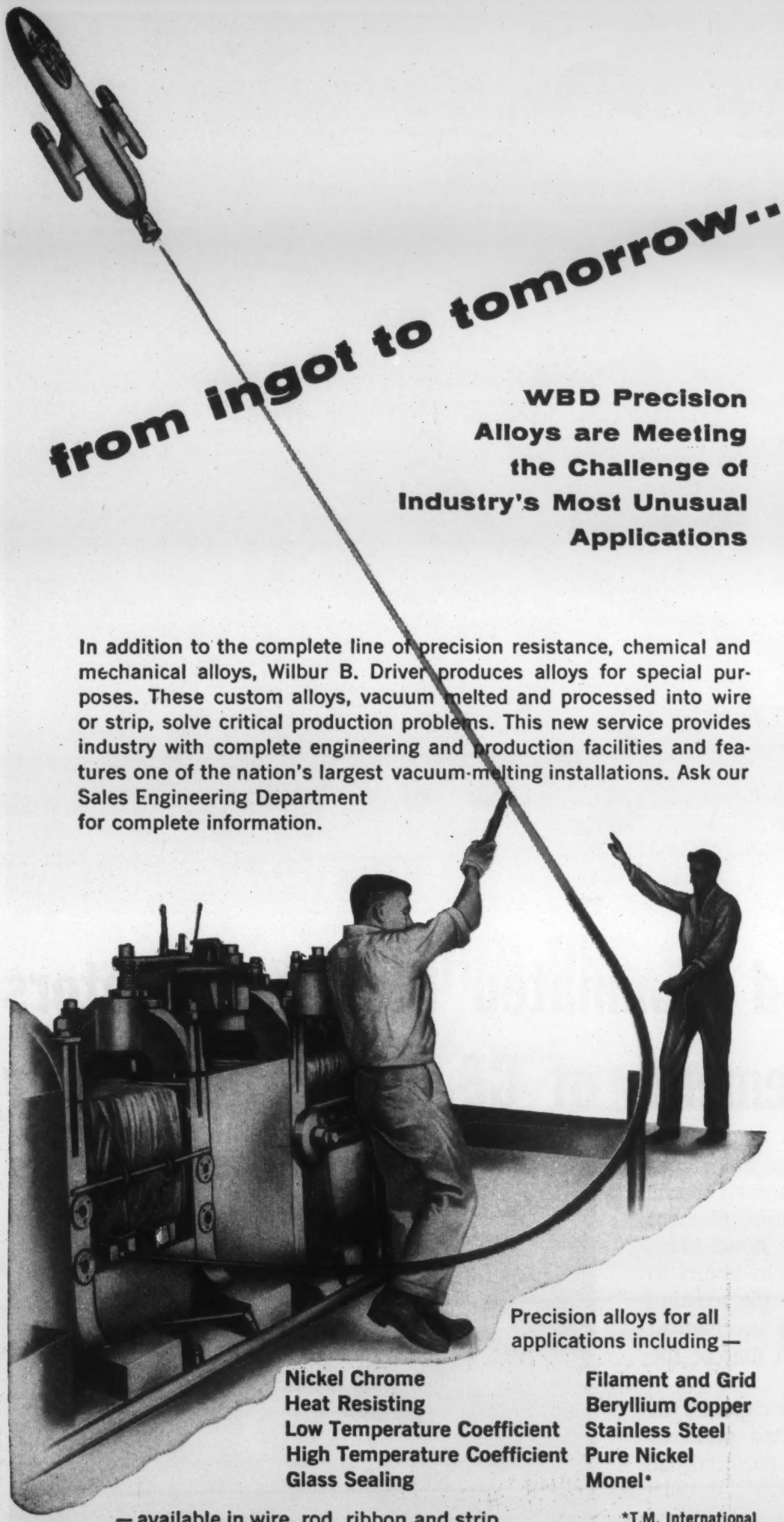

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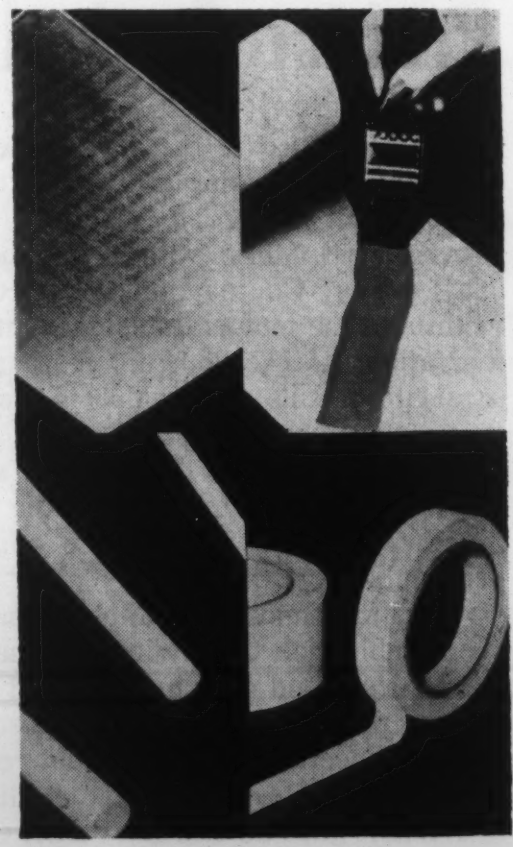
clad sheets and tapes and extruded and molded rods.

1. Copper-clad Teflon

Copper-clad Teflon sheets and tapes for printed circuits are available from Fluorocarbon Products Inc., Div. of United States Gasket Co., Camden 1, N. J. The two products are said to have low dielectric constants, low dissipation factors and low water absorption. The sheets are available 18 x 36 in. wide in thicknesses from 1/16 to 3/16 in. with 1 or 2 oz of copper on both sides. The tapes are available in sizes 12 x 150 in. wide in thicknesses from 0.005 to 0.060 in. with 1, 2 or 3 oz of copper on one or two sides.

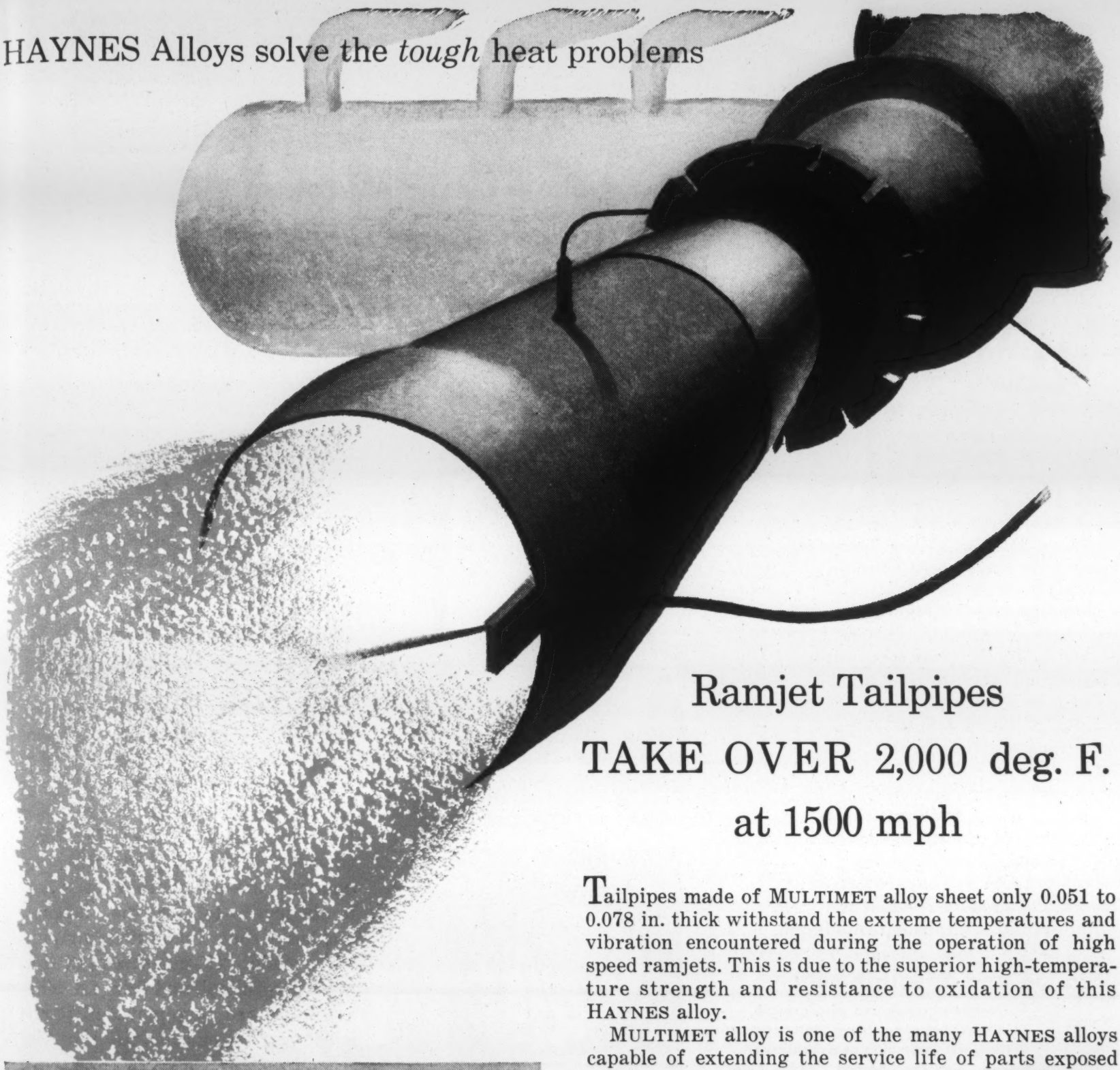
2. Teflon film

A clear Teflon film, designated Type S, has been developed by Dilectrix Corp., Allen Blvd. and Grand Ave., Farmingdale, N. Y. for use as an insulation and liner in solar stills and electronic devices. The film may be painted on one side without affecting its light transmission qualities. The mate-



Teflon products, *such as the sheet, film, rod and tape shown above, have good electrical, chemical and thermal properties.*

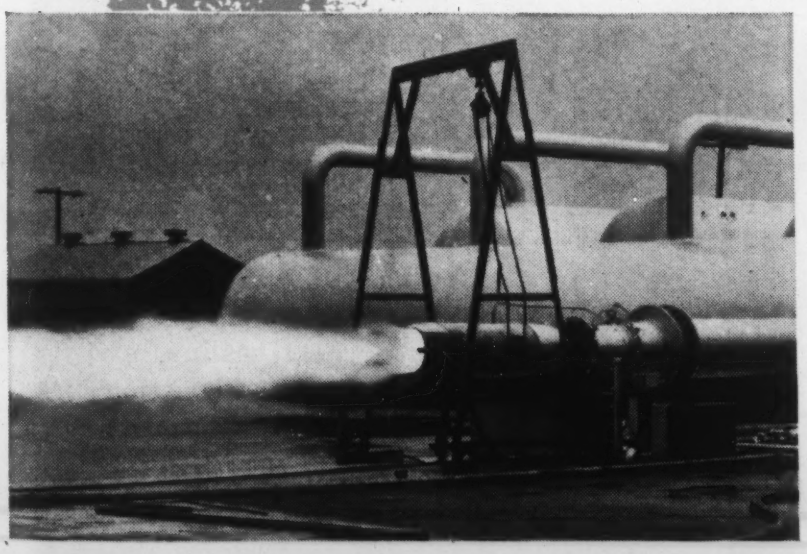
HAYNES Alloys solve the *tough* heat problems



Ramjet Tailpipes TAKE OVER 2,000 deg. F. at 1500 mph

Tailpipes made of MULTIMET alloy sheet only 0.051 to 0.078 in. thick withstand the extreme temperatures and vibration encountered during the operation of high speed ramjets. This is due to the superior high-temperature strength and resistance to oxidation of this HAYNES alloy.

MULTIMET alloy is one of the many HAYNES alloys capable of extending the service life of parts exposed to high temperatures, oxidation, and stress. For descriptive literature write HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana. Or contact our nearest sales office . . . Chicago, Cleveland, Detroit, Houston, Los Angeles, New York and San Francisco.



Ramjet tailpipes are formed from MULTIMET alloy sheet in four sections. The entire assembly is over 2 ft. in diameter at the large end and nearly seven ft. long.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

UNION CARBIDE

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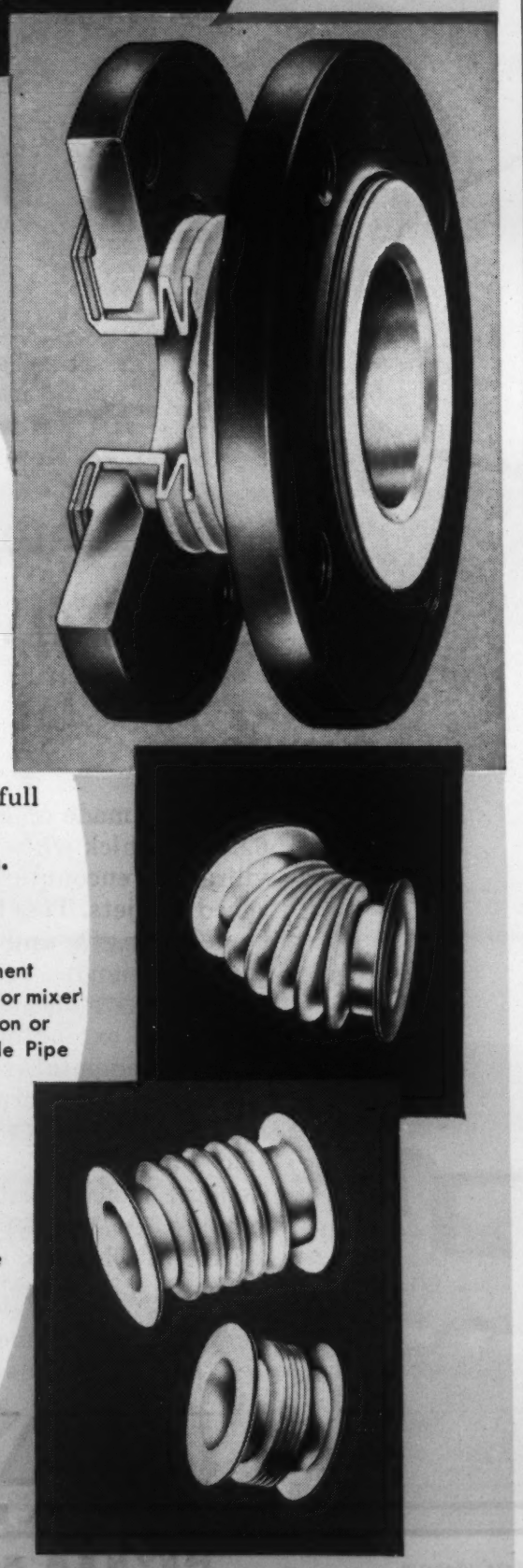
Here's The Plain Truth About
CHEMLON®
Flexible Pipe Connectors

*"John Crane" fabricated from DuPont Teflon



When it is a question of handling corrosive fluids in processing or hydraulic equipment —Chemlon Connectors best meet the need. They are fabricated from the most chemically resistant material available, DuPont Teflon. The most destructive acids, corrosives and solvents have no deteriorating affect*

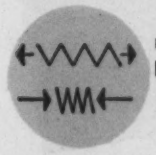
Other important advantages are their long service-life, extreme flexing ability and wide temperature range from —65°F. to +350°F.

Chemlon flexible pipe connectors offer a definite plus value construction-wise. 1) They are made from Teflon specially fabricated for high and uniform density. 2) An exclusive manufacturing method assures uniform wall thickness throughout the convoluted area. 3) They are formed at full free length to reduce residual and working strain to an absolute minimum.

Vibration and Misalignment

—severest vibration and misalignment conditions, such as pump to agitator or mixer to tank, will cause little deterioration or fatigue. Also, the Chemlon Flexible Pipe Connector serves as an acoustical as well as a mechanical dampener.

Expansion and Contraction



—continuous flexing over a wide range of temperature conditions has little affect on Chemlon Flexible Pipe Connectors.

CUSTOM FABRICATED

Chemlon Flexible Pipe Connectors can be custom machined or molded to meet any requirement from one convolution up... any shape or size . . . open or closed end. They handle pressures to 75 psi.

•

Request full information. Crane Packing Co., 6460 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

**Except fluorine and molten alkali metals.*

CRANE PACKING COMPANY

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rial has a dielectric strength of 3200 v per mil, a dielectric constant of 2.0 and a dissipation factor of 0.002. It has a tensile strength of 4000 psi and an ultimate elongation of 400%.

3. Teflon rod, tubing

Twenty-one stock sizes of extruded Teflon rod in sizes up to 2 in. in dia are available from Chicago Gasket Co., 1271 W. North Ave., Chicago 22. The company also stocks 10 sizes of Teflon tubing ranging from ¼ to 1 in. i.d.

Another company supplying extruded Teflon rods is United States Gasket Co., Camden 1, N. J. The company's extruded and molded rod products, designated Garlock 8764, are available in diameters from 0.200 to 2 in. in unground rod and from 0.200 to 1 in. in centerless ground rod.

4. Teflon filter cups

Porous Plastic Filter Co., Inc., Glen Cove, N. Y., recently announced the availability of what is believed to be the largest molded porous Teflon filtering cup ever made. It measures 12 in. high, 5½ in. o.d. and 5 in. i.d. The cup, designed to remove all particles over 3 microns in size, is recommended especially for atomic energy applications.

5. Teflon tapes

A pressure sensitive Teflon tape that sticks to ferrous and nonferrous metals, glass and plastics has been introduced by Chicago Gasket Co., 1271 W. North Ave., Chicago 22. The tape is recommended for heat sealing, electrical insulation and antifriction surfacing. It is supplied in widths up to 2 in. in 36-yd rolls of 0.006-in. thickness and in 18-yd rolls of 0.013-in. thickness.

Titanium Aircraft Parts Extruded from Ingots

Cost of titanium jet engine parts has been reduced by as much as 40% by using a new pro-

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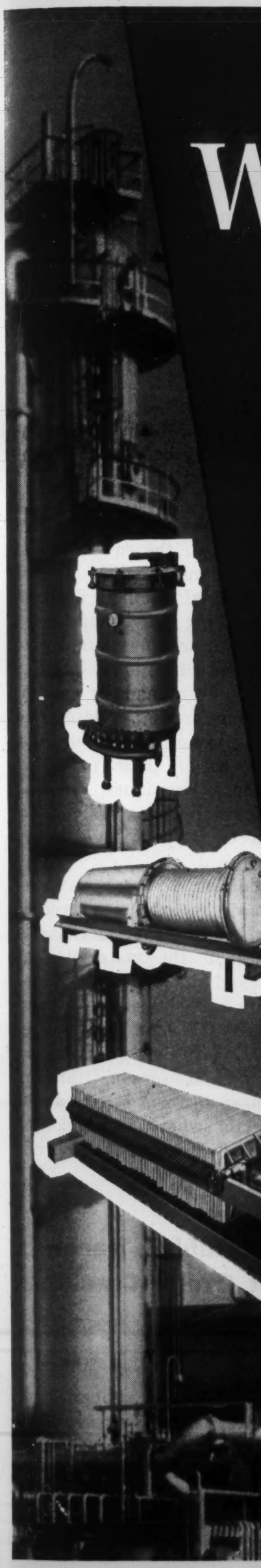

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Windsor Felts are *now* in use on all types of filtration equipment . . . inquire how they can improve *your* operations, write for Data Sheet #18, on company letterhead, please.

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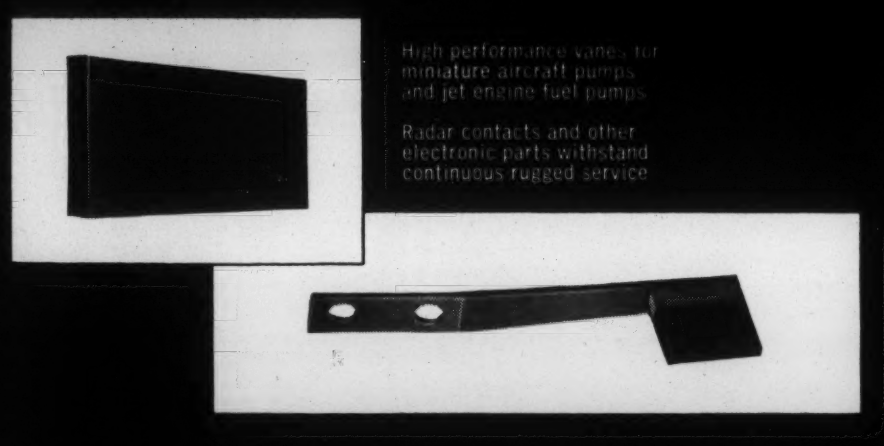
New applications



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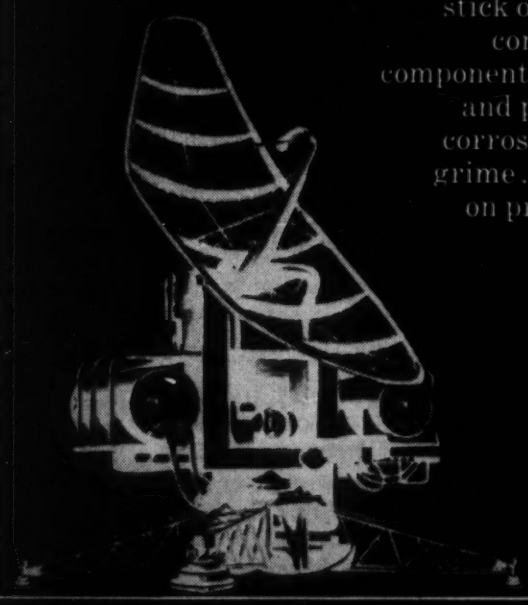

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duction method that extrudes parts directly from cast ingots, according to a joint announcement by the Wright Aeronautical and Metals Processing Divisions of Curtiss-Wright Corp. and the Air Materiel Command, Wright-Patterson Air Force Base.

Neil J. Feola, Wright Aeronautical Div., Curtiss-Wright Corp., speaking before the recent annual meeting of the Society of Automotive Engineers in Detroit, pointed out that the new method uses about half the raw material required to manufacture a part by conventional techniques. Feola said this saving was demonstrated in the manufacture of unalloyed and alloyed titanium annular rings which were made by extruding, contour forming, welding and machining to finished dimensions. Manufacture of these parts by conventional techniques, such as forging, results in grossly oversized sections and high scrap losses, he said.

In addition to cost savings, Feola said the extrusion process also develops superior mechanical properties in the materials extruded, and in all cases these properties exceed specification requirements. He said the process, available to Air Force contractors and commercial users of titanium, can be used to form other expensive metals where scrap losses seriously affect the finished product cost.

Nitrile Rubber Parts Resist Ozone Cracking

Rubber gaskets, o-rings, tubing, fabric coatings, electrical insulation and pump parts made of Hycar 1072 nitrile rubber compounds are said to remain free from ozone cracking 7 to 23 times longer than conventional nitrile rubber compounds. Hycar 1072, developed by B. F. Goodrich Chemical Co., Div. of B. F. Goodrich

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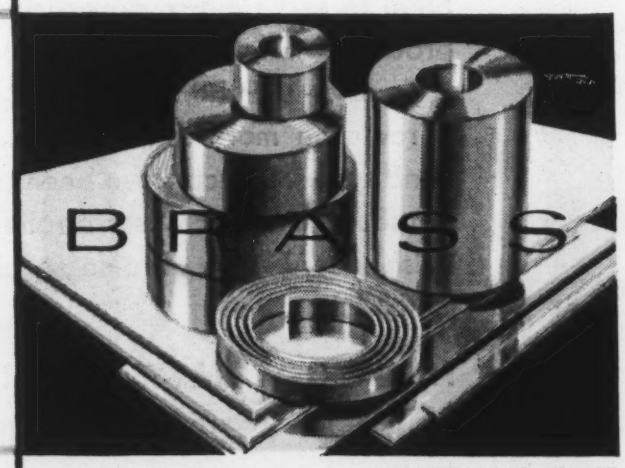

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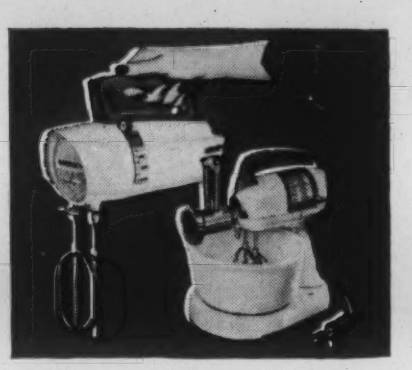

DORMEYER MIXERS
are painted with
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. . . and high quality standards are easily maintained with Electrostatic Spray Painting

Aluminum and zinc die castings of the Dormeyer Mixers are painted uniformly as the parts make a loop around the RANSBURG disk in the job painting plant of Enameled Steel & Sign Co.

● Enameled Steel & Sign Co. is able to serve many customers like Dormeyer, for their Chicago job painting plant is equipped with modern and efficient finishing facilities for producing high quality, high volume painting.

Electrostatic spray painting has practically replaced all other methods here, for the flexibility and near 100% efficiency of the Ransburg No. 2 Process enables Enameled Steel to serve many manufacturers of a wide variety of products. And, this with a comparatively small labor crew!

Today—with Ransburg No. 2 Process—Enameled Steel is realizing more than 60% paint savings over former hand spray. Rejects have been cut to less than 1%, for the Ransburg No. 2 Process applies a uniform, high quality finish never before obtainable with old-fashioned painting methods.

THINK OF WHAT 60% PAINT SAVINGS WOULD MEAN IN YOUR OWN FINISHING DEPARTMENT

Whatever you manufacture, if your production justifies conveyorized painting, you should look into the savings and improved quality which can be yours with Ransburg Electro-Spray. Let us tell you about the complete Ransburg services, including the test painting of your products in our laboratories.

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Indianapolis 7, Indiana

RANSBURG

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What's new IN MATERIALS

Co., 3135 Euclid Ave., Cleveland 15, is a medium-high acrylonitrile-butadiene polymer modified with carboxyl groups.

Laboratory tests reveal that an unprotected conventional nitrile rubber compound develops ozone cracks within 1 hr of exposure, whereas an unprotected Hycar 1072 compound requires 23 hr for local cracking to occur. The addition of an anti-ozonant and wax blended to the same Hycar compound extends its ozone resistance beyond 190 hr. The tests also show that excellent ozone resistance is maintained in Hycar 1072 compounds even after immersion in ASTM No. 1 oil for 70 hr at 212 F.

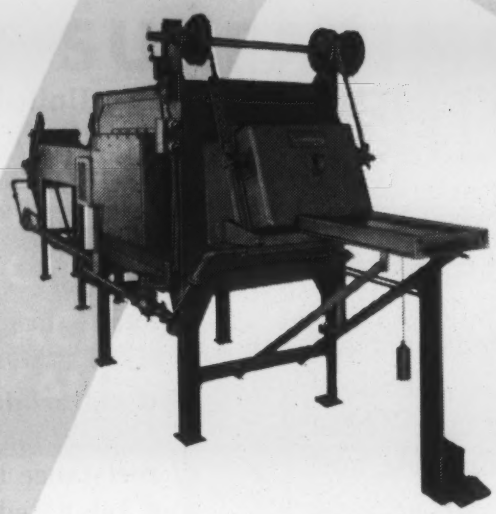
According to Goodrich, rubber parts made of Hycar 1072 should do well in applications where parts are under tension for long periods, since these rubber parts are more likely to be attacked by atmospheric ozone than parts not under tension.

Cobalt Alloys Best for Hydraulic Equipment

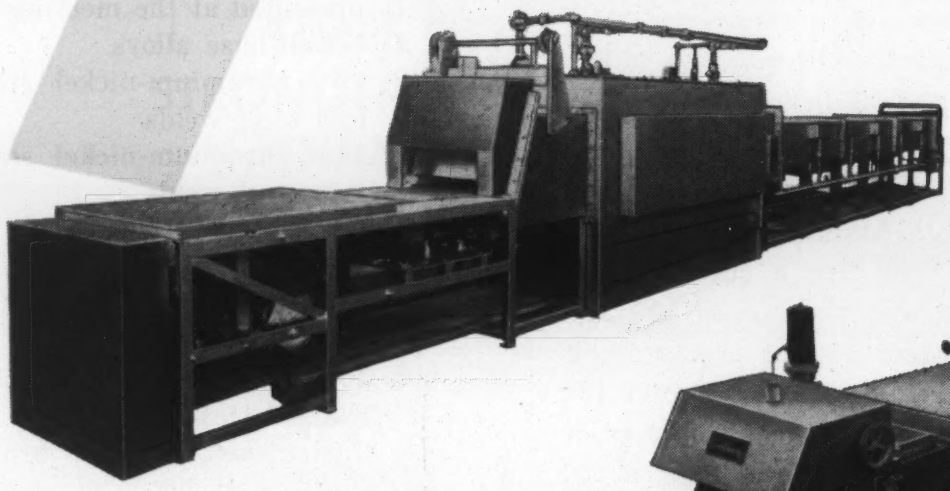
Cobalt-base alloys when used in hydraulic equipment seem to be better than other materials in resisting the damaging effects of cavitation. This is the finding of a group of 35 engineers who participated in the 1956 Cavitation Symposium, sponsored by the Cavitation Committee of the Hydraulic Div., American Society of Mechanical Engineers. A detailed report containing all the data presented at the meeting is now available from ASME.

The report, edited by W. J. Rheingans, Chairman of the Cavitation Committee, is a condensation of 35 years of field and laboratory experience with the resistance of various materials to cavitation damage. It outlines the experience which power companies

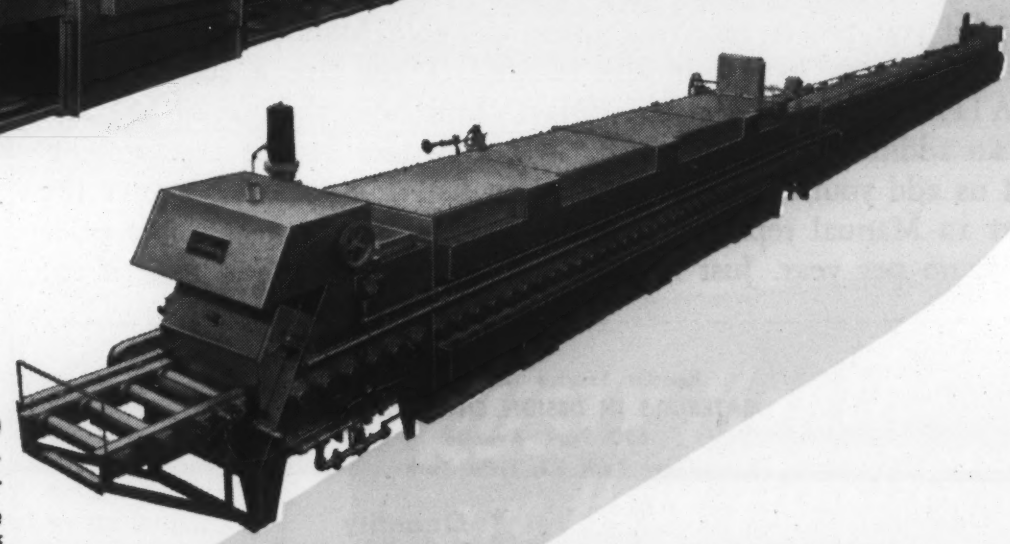
Look to Lindberg for sintering furnaces



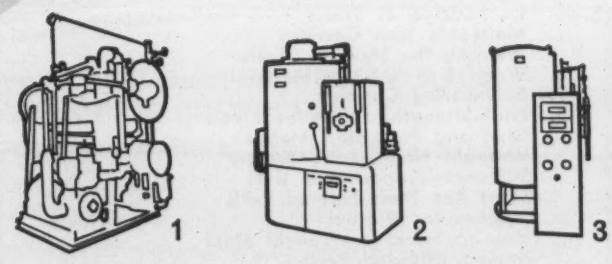
Hand Pusher Batch Type Furnace
For small production lots and experimental sintering. An all-purpose unit for operation from 1300° F. to 2500° F. Made in various sizes for sintering from 25 to 300 pounds per hour.



Mesh Belt Continuous Type Furnace
Sintering furnace for small light parts in copper, bronze, brass or steel. Temperature range from 1300°F. to 2100°F. Provides low temperature silver brazing, bright annealing, as well as sintering of powder metals. Production ranges up to 500 pounds per hour.



Roller Hearth Continuous Type Furnace
Designed to handle loads up to 2200 pounds per hour. Effective temperature range from 1300°F. to 2100°F. For bright annealing, low temperature silver brazing as well as sintering of powder metals.



Lindberg atmosphere generators provide the proper atmospheres recommended for use with Lindberg Sintering Furnaces. These are: 1. HYEX Generator... approximately 4% carbon dioxide—18% hydrogen—12% carbon monoxide and 66% nitrogen. 2. HYEN Generator... neutral atmosphere approximately 21% carbon monoxide—40% hydrogen—38% nitrogen and 1% methane. 3. HYAM Generator... composed of approximately 75% hydrogen and 25% nitrogen.

For sintering furnaces, just as in all types of industrial heating equipment, you can depend on Lindberg's ability to supply exactly the right equipment for your needs. Just get in touch with your nearest Lindberg Field Representative, or write Lindberg Engineering Company, 2451 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 South Regentview Avenue, at Downey, California.

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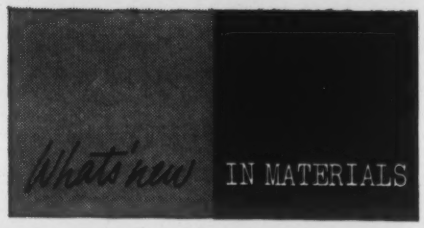

of the United States and Canada have had with such materials as cast iron, cast steel, bronze, various types of chromium-nickel stainless steel welds, cast chromium steel, cast and welded aluminum bronzes, rubber and sprayed materials.

How materials rate

A list of materials in their order of resistance to cavitation damage was tabulated from the mass of data presented at the meeting.

1. Cobalt-base alloys
2. 17-7 chromium-nickel stainless steel welds
3. 18-8 chromium-nickel stainless steel welds
4. Ampco No. 10 welds
5. 25-20 chromium-nickel welds
6. Eutectic Xyron 2-24 welds
7. Bronze castings
8. 18-8 chromium-nickel stainless steel castings
9. Cast nickel-aluminum bronze
10. 13% cast chromium steel

Rubber, sprayed materials, aluminum, bronze, steel castings and manganese bronze castings are generally low in their resistance to cavitation damage.

Results of laboratory tests with various types of accelerated cavitation machines show that the order of resistance of various materials to cavitation damage is practically the same regardless of the type of machine used. In addition, there is a close correlation between field experience and laboratory tests, showing that laboratory testing gives a good indication of what can be expected under field conditions.

Rate of damage

The various discussions during the Symposium touched upon the relation between velocity of the fluid and actual cavitation damage. In the past, the terms "severity of cavitation" and "intensity of cavitation" have been used rather loosely with respect to rate of cavitation damage.

The report points out that since the shape of the guiding surface,

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. . . and that's not all! COROCRETE cuts maintenance cost, gives greater protection and wears longer because it resists impact . . . provides abrasion-resistant qualities five to six times greater than concrete. Quickly and easily applied over existing concrete surfaces, COROCRETE solves corrosion problems common to chemical and food processing plants, as well as plating, pickling and general metal working industries.

The Ceilcote Company offers a complete installation service that takes the burden off designers and engineers. Expert Ceilcote personnel install the grade of COROCRETE recommended by Ceilcote engineers for your protection against corrosion. All materials, workmanship and job satisfaction are fully guaranteed.

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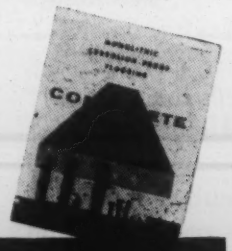

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Positive pressure and exact registration of the part in the mask. Reduce rejects. Free both hands for productive movements.

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Now there's a P&H heat-treatable electrode that matches exactly the carbon content of super-strong metals—responds the same way to post heat-treatment. Result: You eliminate many of the machining problems of weld repairs on castings, forgings, etc.

Low-hydrogen iron-powder coatings and special core wires minimize impurities—prevent hot and cold cracking. You get deeper, smoother penetration with less spatter and slag. Electrodes handle easily—are ideal for .25 and .40 carbon, chrome-moly, and 4130, 4140, and 4340 alloys. Get Bulletin R-48. Write to Dept. 313G, Harnischfeger Corp., Milwaukee 46, Wisconsin.

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P&H welders • electrodes positioners

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What's new IN MATERIALS

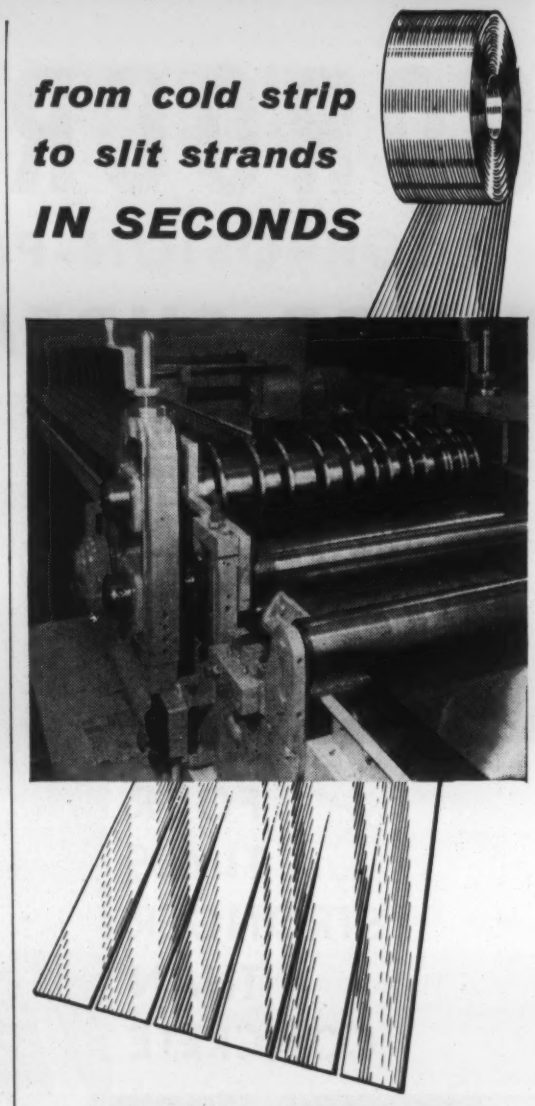
the actual liquid pressure, the vapor pressure of the liquid, and the relative velocity between the liquid and the guiding surface all influence the formation of cavitation zones, it is generally assumed that if any of these conditions become more severe the intensity of cavitation increases. In a sense this is true—any of these conditions can affect cavitation phenomena such as size of cavitation zone, noise, and loss of efficiency in an energy-transfer machine. However, it is now believed that relative velocity, though not the only factor, is probably the most important one in determining the severity or rate of cavitation damage in hydraulic equipment.

Better hydraulic equipment

The report concludes that the next step in the study of cavita-

Clear vinyl tubing—Color coded wiring and printed numbers are easily read through a new "crystal clear" vinyl electrical tubing produced by Irvington Div., Minnesota Mining & Mfg. Co., Irvington, N. J. Called No. 3022 clear vinyl tubing, the material is described as "clear" with none of the off-shade amber or green coloration formerly associated with clear vinyl formulations. It is available in tubing sizes I, II, and III. It has a brittle point of –100 F, a maximum operating temperature of 185 F, a dielectric strength of 300 v per mil, a tensile strength of 2000 psi and an elongation of 300%.

from cold strip to slit strands IN SECONDS



YODER ROTARY MULTIPLE SLITTERS

A Yoder slitter converts mill-width coils of flat-rolled metal into many variable-width strands in amazingly short time. Speed, coupled with great accuracy and low manpower requirements, makes a Yoder slitter an important factor in keeping production and overhead costs down.

Operated by only two men, the Yoder Type 3-48 slitter illustrated is designed to accommodate standard mill-width coils up to 48 inches wide, in a variety of metals and thicknesses. The slit strand widths can be held to within a .004" tolerance.

Even if your steel requirements are as little as 100 tons a month, the savings to be realized in time, manpower and raw material costs alone will pay for a Yoder slitter in the first few months of operation.

There is a Yoder slitter designed and engineered to meet your requirements, and to speed the delivery of "special" width stock in a wide range of large or small sizes. Send for your free copy of the fully-illustrated, 76-page booklet, "Multiple Rotary Slitting Lines."

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For more information, circle No.

FIRST TIME EVER!

Another

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HIGH IMPACT THERMOPLASTIC RESIN

ACHIEVEMENT

TRANSISTOR RADIO CASE CONTINUOUSLY EXTRUDED

PROVIDES FASTER PRODUCTION, EASIER ASSEMBLY, *LOWER MANUFACTURING COSTS...*

Only CYCOLAC measured up to all requirements for the first extruded transistor cabinets ever made! Imagination and engineering provided savings of 87% on dies and engineering costs alone. CYCOLAC also has many other outstanding properties which made this possible. High impact strength, bright glossy colors, light weight, dimensional stability, excellent shock resistance, chemical resistance, and superb electrical properties. Moving smoothly off the production line, extruded profiles are cut to width, speaker openings die-stamped, units inverted, cemented and presto! . . . cases are complete! To add to your profit picture, find out how CYCOLAC can help *you* make more attractive, better products and *save* money!

* Extruded transistor radio cabinets used in Knight-Kits produced by Custom Plastics, Inc., for Knight Electronics Division of Allied Radio Corp., Chicago, Ill.

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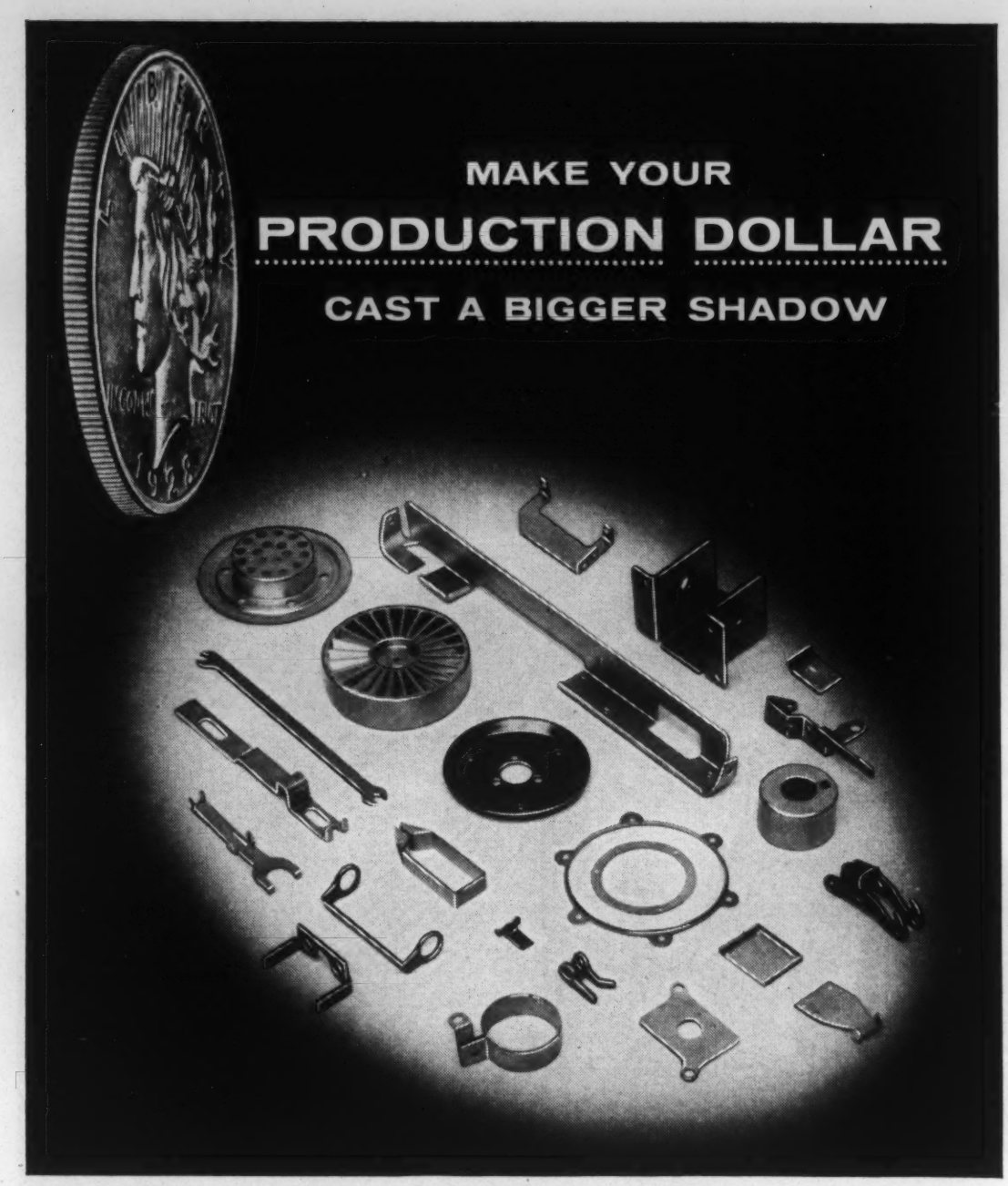

Federal Short Run Stampings may be your answer

Stretch your production tooling dollar up to 80% by using Federal "Controlled Tolerance" Short Run Stampings. That's the savings you get by using the Federal Stamping method instead of conventional tooling methods. You can *put a new product* on the market or make improvements in *existing products* with a *minimum tooling investment*. When quality, fast delivery and price are important factors, try Federal first for any quantity stampings from two pieces to 10,000. Size limitations are 10" x 14" and 3/8" in thickness. Send your print or part to the nearest plant for a Federal Analyzed Quotation.

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For more information, turn to Reader Service card, circle No. 460

tion phenomena should be directed toward determining the relationship between velocity and cavitation damage. The definite establishment of such a relationship with reference to various materials could greatly influence the design and application of hydraulic structures and the materials used in their construction.

Aluminum Oxide Film for Electronic Devices

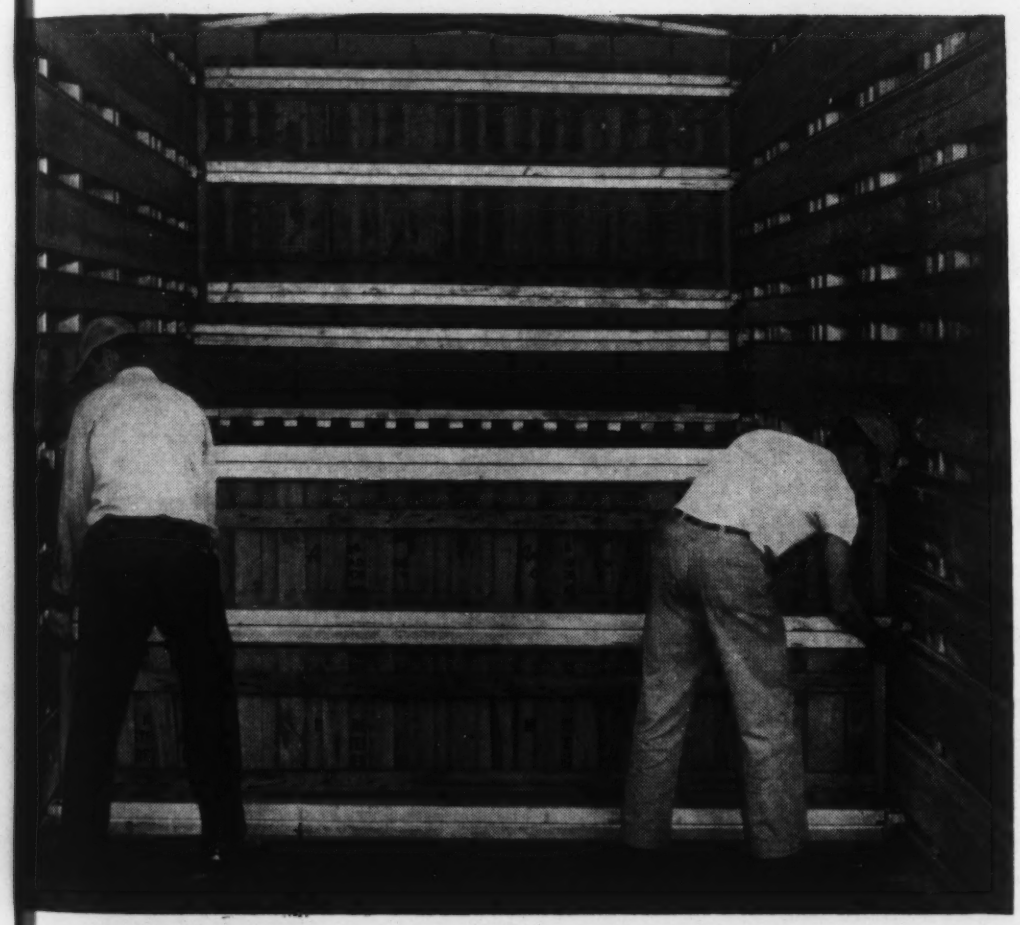
Better electronic devices may come out of the recent development of a transparent and strong aluminum oxide film. The film is presently used to support layers of sensitive material required in electronic imaging tubes. Because the film is extremely thin, electrons traveling through the tube can penetrate the sensitive layers without being interrupted by a

***Preparing film** involves the following: 1) the aluminum oxide coating on one surface of a flat, wrinkle-free piece of aluminum foil is removed by rubbing with a solution similar to common lye, exposing the aluminum metal underneath; 2) the foil is washed in distilled water, dried, and placed in an acid solution which eats away all the aluminum metal, leaving only the thin coating of oxide on the other side of the foil; 3) the film is washed, dried and mounted on a metal ring of the desired diameter.*

These workmen are using Youngstown Yoloy "E" high-strength steel to fabricate belt rails — a component of DF Loaders — at Evans Products Co.

Accent on Excellence

Youngstown Yoloy "E" high-strength steel



EVANS DF LOADER . . . *Locks in lading, eliminates damage and dunnage*

Two DF* Loader-equipped railroad cars easily do the work of three standard box cars. That's because DF cars (31,000 now in service) can be loaded to capacity—earn greater revenue for railroads.

Portions of Evans DF Loaders are fabricated from Youngstown's Yoloy "E" Angles and Hot-Rolled Yoloy Sheets by Evans Products Company, Plymouth, Michigan. All Yoloy Steels are produced to meet a wide range of applications, where high strength and corrosion-resistance are of prime importance.

Wherever high strength steel becomes a part of things *you* make, the high standards of Youngstown *quality*, the personal touch in Youngstown *service* will help you create products with an "accent on excellence".

**DF is a trademark of Evans Products Company.*

Send for free technical bulletin on Youngstown Yoloy "E" Steel.

QUALITY YOUNGSTOWN SERVICE

THE
YOUNGSTOWN
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Manufacturers of Carbon, Alloy and Yoloy Steel, Youngstown, Ohio

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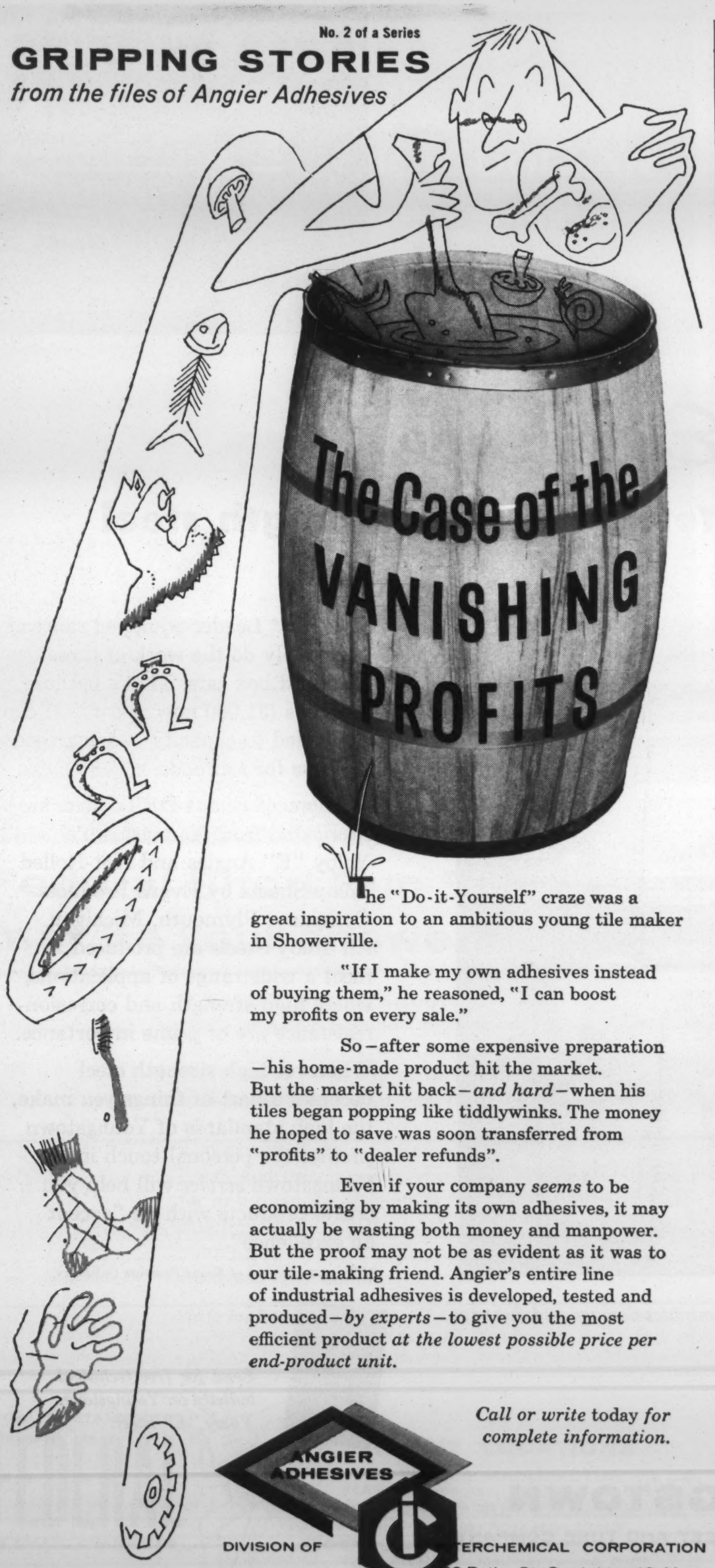
No. 2 of a Series

GRIPPING STORIES

from the files of Angier Adhesives



The "Do-it-Yourself" craze was a great inspiration to an ambitious young tile maker in Showerville.

"If I make my own adhesives instead of buying them," he reasoned, "I can boost my profits on every sale."

So—after some expensive preparation—his home-made product hit the market. But the market hit back—*and hard*—when his tiles began popping like tiddlywinks. The money he hoped to save was soon transferred from "profits" to "dealer refunds".

Even if your company *seems* to be economizing by making its own adhesives, it may actually be wasting both money and manpower. But the proof may not be as evident as it was to our tile-making friend. Angier's entire line of industrial adhesives is developed, tested and produced—*by experts*—to give you the most efficient product *at the lowest possible price per end-product unit.*

Call or write today *for complete information.*

ANGIER ADHESIVES

DIVISION OF TERCHEMICAL CORPORATION
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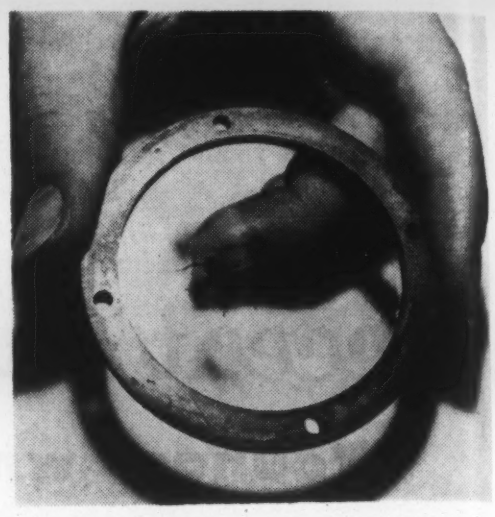
What's new IN MATERIALS



Finished film, *with a thickness only about 1/20 of the wave length of the light rays passing through it, looks like this after being mounted in a metal ring. The film has a tensile strength about equal to that of ordinary steel. It supports itself over relatively large surface areas, and it withstands comparatively large external forces applied to it during preparation and handling.*

supporting structure in the tube.

The film has been known for several years but was too large and too thick to be practical. Scientists at Westinghouse Research Laboratories, Pittsburgh, Pa. have now overcome these drawbacks by chemically dissolving aluminum foil and saving the thin aluminum oxide which coats the foil to a depth of less than a millionth of an inch.

Quartz Cubes, Rods Formed by Forging

Quartz users can eliminate up to 95% of their wastage of this strategic material by using custom forged special quartz shapes, according to Amersil Quartz Div., Engelhard Industries, Inc., 685 Ramsey Ave., Hillside 5, N. J.

The firm announced recently that it is now prepared to forge fused quartz blanks to most customers' specifications; among the shapes available are rods, cubes, briquets and prisms. Heretofore,

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When it's time to talk **tubing**...

WHEATLAND ELECTRIC WELD STEEL TUBING

- Completely inspected—inside and out
- Tested for strength and bendability
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- Extra clean surface

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Shown 1/20 actual size

HACKNEY shapes save for missile producers, too!

The Hackney Method of producing components by deep drawing cold steel, widely used in many industries, produces missile parts economically.

Hackney produced components give engineers more latitude for solving design problems. Savings can be made in over-all weight, assembly time, and through elimination of nonessential parts.

Hackney deep drawn seamless parts provide maximum strength with minimum weight, resist both internal and external pressures.

Consult with Pressed Steel Tank Engineers

The Hackney Method may be the answer to some of your stubborn production problems. Let us know what you want to do. A simple sketch will be helpful. Since we work in steel, stainless steel, nickel, aluminum, magnesium, copper and alloys, add a note about the metals you have in mind. Our engineers will have some practical ideas to send you. Write:

Pressed Steel Tank Company

Manufacturer of Hackney Products

1442 South 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

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What's new IN MATERIALS

Typical shapes *made possible by a new fusing and forging process that turns out smooth quartz parts.*

fused quartz was generally available only in standard cylindrical ingots which had to be ground to rough shape before finishing into a final product.

Amersil's quartz shapes are made by a new fusing process which is said to produce parts with smooth, uncrazed surfaces. The fusing process is also said to produce a more homogeneous material with less thermal strain and fewer and smaller bubbles than in conventionally processed fused quartz.

Metal Powders Are Dimensionally Stable

Two new iron metal powders, called HS and MS, have been developed by Republic Steel Corp., Metal Powder Div., Toledo 5, Ohio. Republic says both metal powders have good dimensional stability and can be pressed and sintered in conventional equipment and dies without excessive shrinkage.

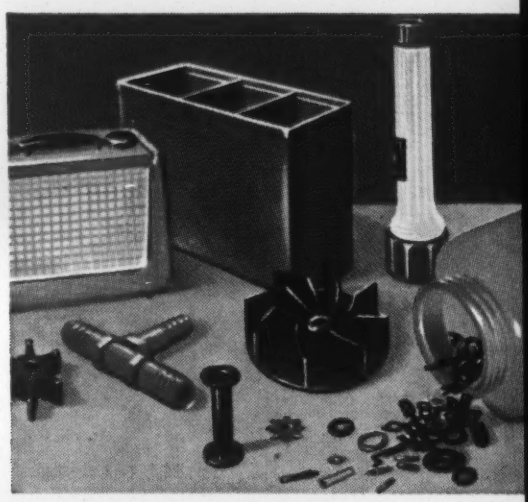
HS metal powder is a hydrogen-reduced, low alloy iron powder containing small amounts of nickel and molybdenum. An HS iron powder part has a tensile strength of 75,000 psi and a density of 6.7 gm per cu cm after pressing at 40 tsi and sintering at 2030 F in

For more information, circle No. 514 ➤

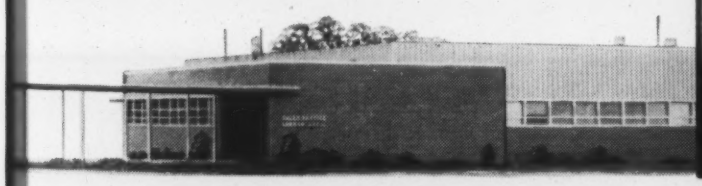
A Low-cost Material that meets Heavy-Duty Requirements!

MARLEX*

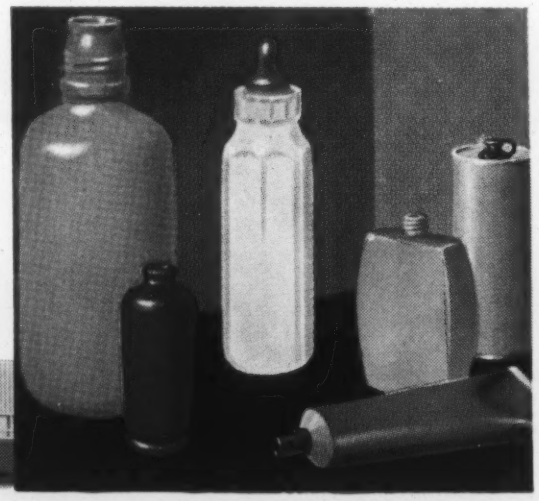
RIGID **POLYETHYLENE**



MARLEX polyethylene is the preferred molding resin for a wide variety of heavy-duty industrial uses . . . wheels, corrosion-proof pump impellers, low-load gears, and self-lubricating bearings . . . glossy, colorful appliance housings, pipe thread protectors . . . and many other die-cast items requiring a low-cost, tough, abrasion-resistant plastic that is chemically inert.



New Sales Service Lab at Bartlesville is completely equipped with latest commercial processing machinery and research apparatus. Phillips experienced technical service staff will assist you in developing new products and processes using MARLEX plastics. Please make arrangements through your local MARLEX sales representative. Meanwhile, for complete data on MARLEX, send for our latest technical bulletins.



Ease of extrusion, low permeability, chemical resistance and rigidity of MARLEX plastic make it ideal for blow molding many types of food and drug bottles, squeeze bottles and aerosols. Its stiffness permits reductions in wall thickness with consequent savings of resin. Conventional processing techniques produce high-quality products with glossy surfaces and minimum internal stress.

Toys and housewares are a natural for this unbreakable, heat-resistant, nontoxic material. Its high tensile and impact strength and lack of brittleness at extremely low temperatures suggest many new applications unsuited to conventional polyethylenes. Molders can profit from the fact that form stability at higher temperatures frequently permits quicker mold ejection and shorter cycle times.

*MARLEX is a trademark for Phillips family of olefin polymers.

PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma

A Subsidiary of Phillips Petroleum Company

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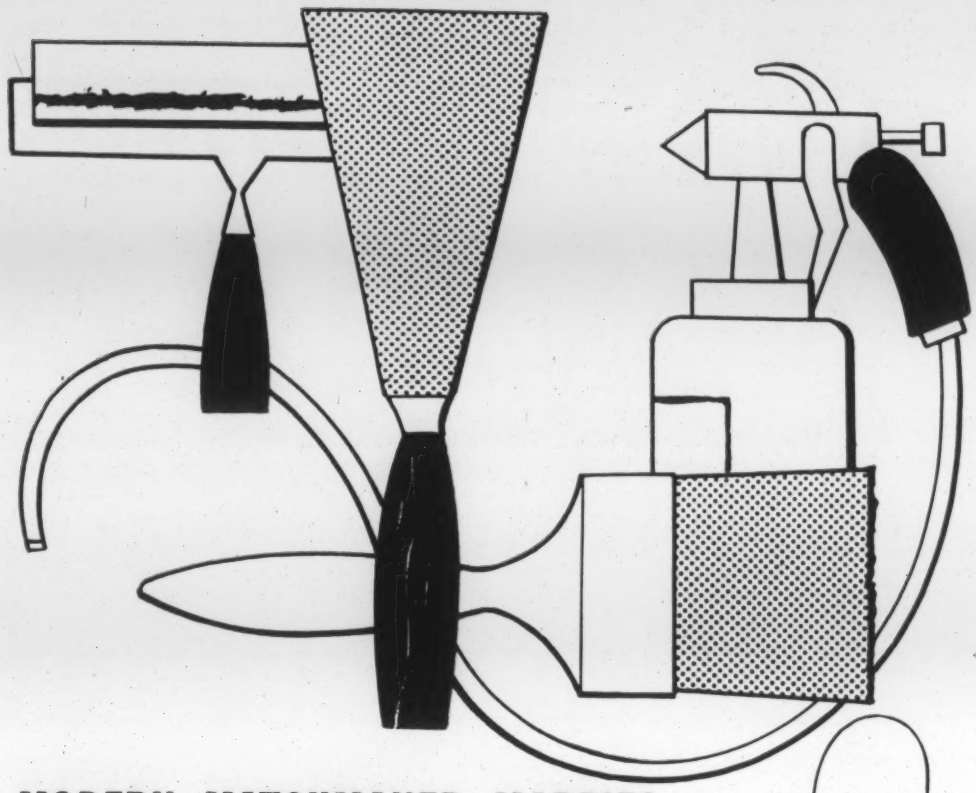

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Versatile Application by brush, knife, dip, roller or heat seal methods. **Versatile Vinyl Cordobond® Adhesives.** Improve production methods with these Cordobond Adhesives. Clear or tinted fast setting or heat activated for bonding or laminating application.

CORDOBOND ADHESIVES

No.	70	80	82	89D	153	FS219A
Type	Quick Bonding	Med. Speed Bond.	Med. Speed Bond.	Med. Speed Bond.	Med. Speed Bond.	Heat Seal Laminating
Wt/Gal.	8½	7½	7¾	7½	7⅓	7¾
Solids %	32	17	35	35	27	25
Method						
1. Brush	1	1	1	1	1	1
2. Spray	2	2	2	2	2	
3. Dip	3	3	3	3	3	3
4. Coat	4	4	4	4	4	4
Drying Conditions — All adhesives are air or forced heat dried (150°F)						
(Dry) Flow Temp.	250°	250°	250°	265°	260°	300°
Use	Gen'l Purp.	Gen'l Purp.	Spec. Purp.	Spec. Purp.	Spec. Purp.	Spec. Purp.
Plastics to	Wood Paper Plastics	Metal Polystyrene	Metal Polystyrene	Acetate Butyrate Polystyrene	Vinyls to Vinyls	Metallized Mylar & Metal

Thinner — For Brushing Use — 2027 — Med. Fast Solvent
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☐ 1 pint sample Cordobond for $1 C.O.D. to cover handling.

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CORDO CHEMICAL CORPORATION
34 Smith St., Norwalk, Conn.

For more information, turn to Reader Service card, circle No. 501

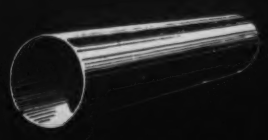
What's new IN MATERIALS

an atmosphere of Endo gas for 40 min (dew point 12 F). Graphite is added to the powder. According to the producer, the sintering atmosphere should be such as to maintain the carbon content of the metal powder. The die is lubricated with zinc stearate.

For high density, high strength parts, Republic says that HS powder, pressed at 40 tsi, annealed at 1250 to 1300 F, re-pressed at 40 to 50 tsi in the same die, and sintered in an Endo atmosphere (dew point 12 to 30 F) at 2030-2050 F for 20 to 40 min, has the following properties: 6 to 10% elongation; 80,000 to 100,000 psi tensile strength; 7.2 to 7.4 gm per cu cm density; and less than 0.004 in. per in. dimensional change.

For highly stressed parts, Re-

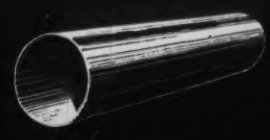
Sapphire joined to metal—A process similar to that used for making high temperature ceramic-to-metal seals is used by Ceramaseal, Inc., Box 25, New Lebanon Center, N. Y. to form the synthetic sapphire-to-metal seal shown above. The sapphire parts, available in disks up to 3 in. in dia and in tubes up to ½ in. in dia, are joined to both ferrous and nonferrous metals. Some current uses for the sapphire seal assemblies are waveguide windows for radar equipment and high temperature windows for high vacuum apparatus, fire detection equipment, and ultraviolet studies in nuclear energy.



Armco ZINCGRIP® STEEL Tubing

Full-weight hot-dip coating of zinc does not flake or peel during severe fabrication. Resists rust.

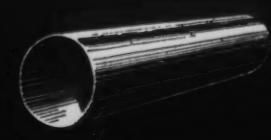
Available in O.D.'s from ⅜-inch to 3 inches; gages from 12 to 20; mechanical or pressure-tested tubing; round, square, rectangular, or special shapes.



Armco ALUMINIZED STEEL Type 1 Tubing

Hot-dip coating of aluminum won't discolor to 900 F—resists destructive heat scaling to 1250 F. Assures top resistance to combinations of heat and corrosion.

Available in O.D.'s from ⅜-inch to 3 inches; gages from 13 to 20; mechanical or pressure-tested tubing; round, square, rectangular, or special shapes.



Armco ALUMINIZED STEEL Type 2 Tubing

Also hot-dip coated with aluminum, provides outstanding resistance to atmospheric corrosion. Serves longer outdoors.

Available in O.D.'s from ⅜-inch to 3 inches; gages from 13 to 20; mechanical or pressure-tested tubing; rounds only.

for *extra* life at low cost...

Durable Coatings of Zinc or Aluminum Protect 3 Special Grades of Armco Tubing

Armco Coated Tubing grades offer all the design advantages of welded steel tubing, *plus low cost protection against corrosion.*

Special hot-dip coatings of zinc or aluminum eliminate the need for painting, plating, or other costly finishing. Just select the grade that supplies the cost-performance combination that your product requires.

For complete information, fill in and mail the coupon.

Other Armco Steels for top-quality products include Stainless Steels, ALUMINIZED STEEL, ZINCGRIP®, ZINCGRIP PAINTGRIP®, Cold-Rolled PAINTGRIP, Enameling Iron, High Strength Steels, Electrical Steels, Long Ternes, and high-quality Hot- and Cold-Rolled sheets.

ARMCO STEEL CORPORATION
1588 Curtis Street, Middletown, Ohio

Send me information on
- ☐ Armco ZINCGRIP Steel Tubing
- ☐ Armco ALUMINIZED STEEL Type 1 Tubing
- ☐ Armco ALUMINIZED STEEL Type 2 Tubing

We manufacture_____

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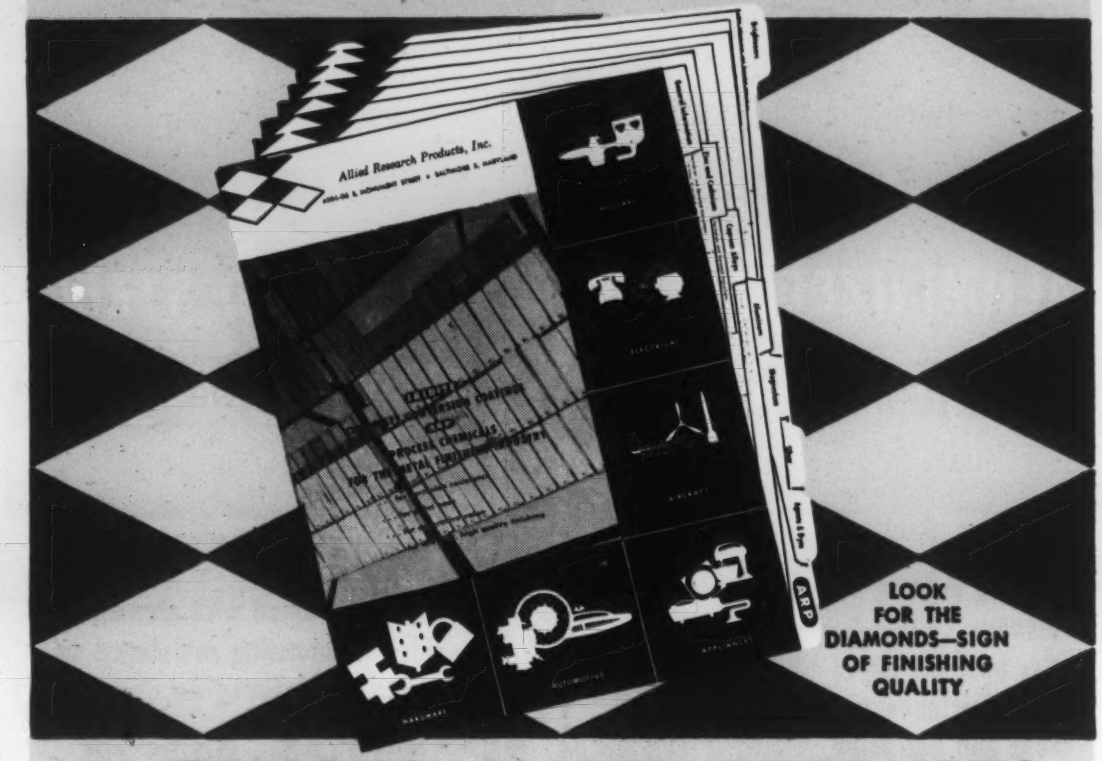
For more information, turn to Reader Service card, circle No. 454

Useful Technical Data File...



on FAMOUS ALLIED PRODUCTS

For Finishing, Cleaning and Protection of Metals

Here's a wealth of technical information gathered as a result of extensive product research, development and use throughout the world. This comprehensive file explains and describes all products, gives applicable metals, appearance of film, purpose of products, typical applications, U. S. Government specifications, method of application and test results.

IRIDITE® The finishing industry's most complete line of chromate conversion coatings. Give peak corrosion resistance, a lasting paint base and widest choice of appearance in decorative finishing on

ZINC AND CADMIUM ALUMINUM CUPROUS ALLOYS MAGNESIUM SILVER

ARP® BRIGHTENERS Liquid and powder materials for barrel, still or automatic ZINC and CADMIUM plating. High chemical stability provides maximum quality at minimum cost. Liquids available in AUTO-FLO-PAK for economical automatic dispensing.

ARP® PROCESS CHEMICALS

WETTING AGENTS DETERGENTS DYES FOR IRIDITE FILMS

ARP® CLEANERS and DEOXIDIZERS Specially formulated to provide maximum performance with IRIDITE coatings on aluminum and zinc die castings.

IRILAC™ New method of protection incorporating corrosion inhibitors in a water-soluble polymer base which dries to an extremely thin, tough, durable coating —clear in color. Does not chemically affect base metal or any post treatments. Used as a protective treatment alone or to enhance value of post treatments.

Write now for your copy of Allied's Technical Data File, or call your Allied Field Engineer for full information on Allied products. He's listed in your phone book under "Plating Supplies".

Your Finishing Problems Invited

Our Research and Development Department will be happy to work with you to develop a finish for your needs.

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4004-06 E. MONUMENT STREET
BALTIMORE 5, MARYLAND

***Manufacturers* of IRIDITE®, IRILAC™, ARP® Brighteners and Plating Chemicals—West Coast Licensee: L. H. Butcher Co.**

For more information, turn to Reader Service card, circle No. 482

What's new IN MATERIALS

public says that an annealed HS iron powder part heat treated at 1500 to 1600 F for 15 min, quenched in oil, and tempered at 350 to 1000 F, has the following properties: 1 to 3% elongation; 170,000 to 200,000 psi tensile strength; 7.2 to 7.4 gm per cu cm density; and less than 0.004 in. per in. dimensional change.

MS metal powder is a hydrogen-reduced, straight iron powder. Republic says, ". . . MS metal powder can be used to make structural parts at a lower cost than parts made from copper-containing iron powder." Anticipated uses for the metal powder are electric motor cores, pole pieces and armatures.

A typical MS iron powder part has a tensile strength of 55,000 psi and a density of 6.7 gm per cu cm after pressing at 40 tsi and sintering at 2030 F in an atmosphere of Endo gas for 45 min (dew point 12 F). Graphite is added to the powder. The die is lubricated with zinc stearate.

Plastics Tooling for Short Run Dies

A new plastics tooling compound has been developed by Minnesota Mining & Mfg. Co., 900 Bush St., St. Paul, Minn. for short run production dies. According to 3M, a die composed of the compound can turn out 600 cold rolled steel shapes an hour.

The die material, called Compound 113, is composed of two parts: Part A, a treated ferrous metal powder that can be formed into shapes having good dimensional stability; and Part B, a thermosetting liquid epoxy resin used to impregnate the metal powder preforms to make them permanent and durable. According to the producer, the metal powder-epoxy compound can cut tooling costs by as much as 85%.

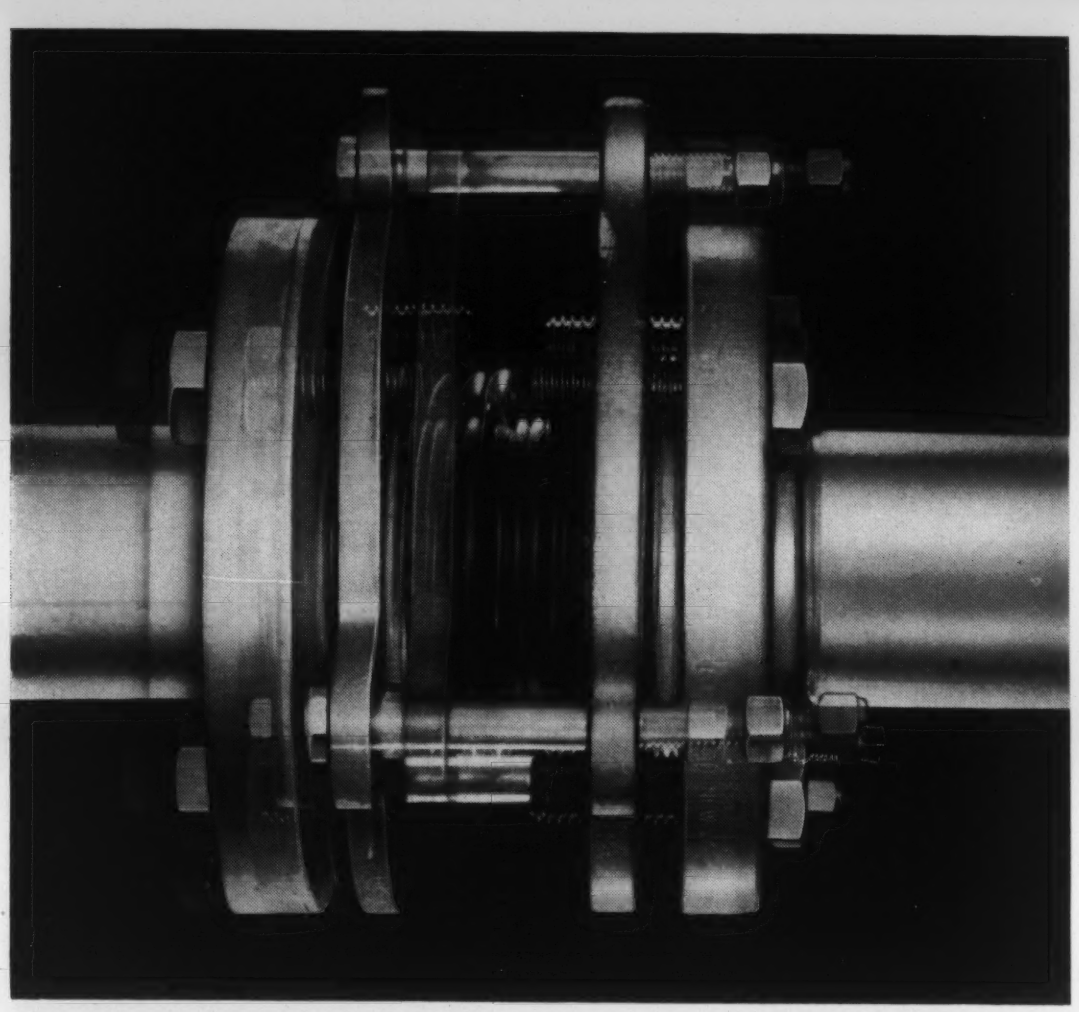
Compound 113 has a compres-

That's why designers specify stainless for so many places where other metals just won't do. For no other metal combines so much *utility* and *solid, lasting beauty!* Stainless steel resists corrosion and denting. It doesn't peel or rust. It can be made "new" again with mere soap-and-water washing. So remember — if the design calls for beauty that simply won't wear out, specify stainless steel. Remember, too, that the very best stainless steels are made with Vancoram Ferro Alloys! Vanadium Corporation of America, 420 Lexington Ave., New York 17, N. Y. Producers of alloys, metals and chemicals.

VANCORAM

VANADIUM CORPORATION OF AMERICA

For more information, turn to Reader Service card, circle No. 391



Fluoroflex®-T expansion joints molded from Teflon® **stand higher dynamic pressure**

Wide pressure range — full vacuum, too

Unequalled flex life — through special Teflon compound

Molded — not machined — for undamaged grain structure and interior convolutions that don't fatigue and crack

Corrosion-proof — universally useful with all fluids, all piping

Fluoroflex-T bellows and flex joints are made of a special high density compound . . . Teflon at its best. Molding assures the optimum tensile and fatigue strength.

RESULT: *Twice the burst strength,* after flexing . . . 20 to 30 times the flex life of ordinary bellows machined from Teflon!

Chemically as well as physically durable, Fluoroflex-T bellows are inert to virtually all known chemical and corrosive solutions.

Investigate their full advantages—write for Bulletin B-1. RESISTOFLEX CORPORATION, Roseland, New Jersey. Southwestern Plant: Dallas, Texas. Western Plant: Burbank, Calif.

® Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
® Teflon is DuPont's trademark for TFE fluorocarbon resins.

RESISTOFLEX

For more information, turn to Reader Service card, circle No. 423

What's new IN MATERIALS

Minnesota Mining & Mfg. Co.

Plastics die *as it looks after impregnation, curing and finishing.*

sive strength of 24,000 psi and a notched Izod impact strength of 0.4 ft-lb per in. of notch. It has a thermal conductivity of 0.6 Btu/hr/sq ft/°F/in. which is said to prevent heat build-up during drawing operations. The cured tooling compound, said to be more than 90% steel, can be drilled, tapped and ground by ordinary machining processes.

Compound 113 sells for $2 per lb for orders of 500 lb or more and $12 for a 4-lb sample kit. (For information on plastics tooling for medium run production dies see MATERIALS IN DESIGN ENGINEERING, Mar '58, p 145.)

Silicone Sponge Parts Keep Their Shape

General Electric Co., Silicone Products Dept., Waterford, N. Y., has announced the commercial availability of two silicone sponge rubber compounds that were first developed about two years ago (see MATERIALS & METHODS, June '56, p 169). The compounds, designated SE-546 and SE-547, are said to be the first to make possible the production of silicone sponge rubber parts to close dimensional tolerances. Both are said to meet the requirements of AMS specifications for silicone sponge, and both are said to surpass organic sponges in their resistance to ozone and weathering.

In addition to good ozone and

Good motors are better with CDF Micabond® insulation

Making or specifying motors or generators? Regardless of the size and type, they'll run better, last longer with genuine CDF Micabond insulating components.

Classes H and B. Micabond is produced in various grades to meet heat requirements of Class H and Class B insulation. Commutator "V" rings, bushings, segments, slot liners, and many other insulating parts of a motor are natural applications for this superior basic material. Certain Micabond grades are readily formed and fabricated into standard or special parts—by you or by CDF.

Complete mica line. CDF offers the designer a complete line of quality mica products, from unfabricated sheets, tubes, and flexible tapes to large or small V-rings, segments, and fabricated parts. For wrapping applications, combinations of Micabond and "Mylar" polyester film, Micabond and glass-fabric, and other combinations are readily available in flexible sheet and tape form.

Fabrication facilities. CDF has the facilities and know-how for turning out finished Micabond insulating parts—better and more economically than you can do it yourself. We meet *your* specifications and *your* production schedules, and save you time and money.

Send us your print or your problem; we'll return pertinent technical literature and recommendations. For the phone number of the CDF sales engineer nearest you, see Sweet's, Electronics Buyers' Guide, and the other directories.

CDF makes Di-Clad* printed-circuit laminates, Diamond® Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto® laminated plastics, Celoron® molded products, Micabond mica products, Spiral Tubing, Vulcoid®.

*Trademark of Continental-Diamond Fibre Corporation
†duPont trademark for its TFE-fluorocarbon resin

CDF

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 25, DEL.

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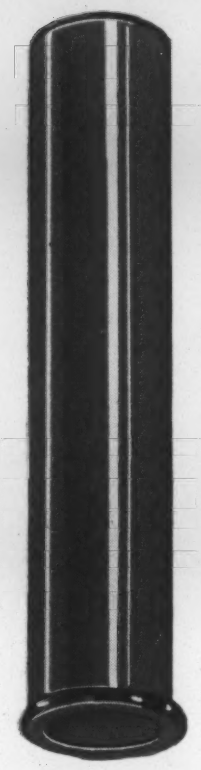
introducing . . .

4.50 GRAMS



ACTUAL SIZE

The New Look in LITHIUM COPPER CARTRIDGES

Lithium isn't new to foundrymen. But the new, improved, 4.50 gram cartridge is. Thinner walls react with the melt faster. Nearly 100% greater compactness means savings in weight and storage space. New "Compression-Spin" seal assures longer shelf life. Over 99.9% copper assay offers the near-ultimate in purity.

Three other handy sizes, 2.25 and 9.0 gram cartridges, plus a 108.0 gram charge in cup form, offer any combination of weights for introducing any percentage of lithium in the melt.

The 4.50 gram cartridge represents 0.010 lbs. of lithium rod. It will refine 200 lbs. of copper or copper-base alloy. All oxygen is removed, fluidity increased, pouring temperature often lowered, oxide and slag inclusions reduced, grain refined, and gas cavities eliminated—*with no change in conventional melting and casting processes.*

The end result is a superior casting: sounder, denser, more uniform, more electrically conductive—at less trouble and less cost. Write for details.

DISTRIBUTORS:

NIAGARA FALLS SMELTING & REFINING DIVISION
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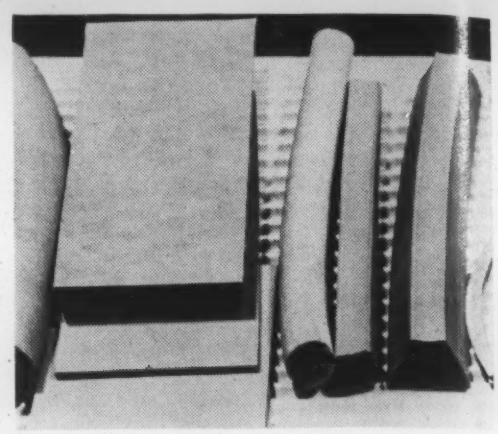


***Typical shapes** that can be molded or extruded from two silicone sponge rubber compounds.*

weathering resistance, the two compounds are said to have good electrical, thermal and physical properties. Both are usable at temperatures ranging from –120 to 500 F. SE-546 meets the requirements of AMS 3196 for firm, closed cell sponge, whereas SE-547 meets the requirements of AMS 3195 for medium, closed cell sponge.

Silicone sponge made of these compounds can be used for various types of seals and gaskets for aircraft, rockets and missiles, and electrical and electronic equipment.

Silicone Rubber Has Low Compression Set

A series of silicone rubbers with much greater resistance to compression set at high tempera-

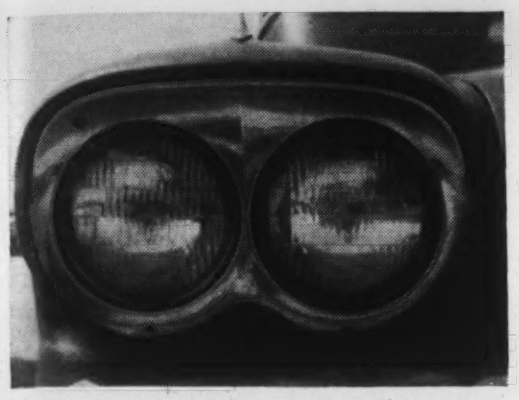
PROPERTIES OF SILASTIC 2090U SERIES

Type ➡	2096U[a]	2098U[b]
Specific Gravity	1.23	1.32
Durometer Hardness	A60	A75
Tensile Strength, psi	600	850
Elongation, %	110	100
Tear Strength, lb/in.	30	60
Brittle Point, F	—100	—100
Compression Set, %		
70 Hr at 300 F	7	17
22 Hr at 480 F	45	85
Molding Shrinkage, %	2.7	1.7

[a]Vulcanized with Silastic S-2084.
[b]Vulcanized with 2,4-dichlorobenzoyl peroxide.

THIS IS GLASS

a bulletin of practical new ideas from Corning



On the beam

It looks as if the four-eyed automobile is here to stay. The reason?

The old style 7-inch lamp had two filaments and was a *compromise* design since *neither* high nor low beam operated at peak efficiency.

New style lamps are smaller ($5\frac{3}{4}$″) and are mounted two-to-the-fender. The outer light is a passing (low) beam, aimed just below and to the right of dead ahead. It also has an auxiliary high beam which is used with the high beam of the inner lamp. Net result: *More light* where you can use it . . . on the road and free of glare.

Though the lenses used in these lamps don't look complex, each is precision-made from heat-resistant glass. Pressed into the surface of every lens are some 100 prisms, each *held to* ±.1° in production.

There's also a glass parabolic reflector for each lens—the combination being a neat example of *mass* production of *precision* glass products. Also involved: Hermetic sealing of glass and metal parts.

Corning currently produces components for some 250 different sealed beam assemblies, with sizes ranging from 2 to 8 inches in diameter.

You may not need headlights, but if you have a problem involving light control, Corning may have the answer. And don't overlook the savings you can realize from mass production of precision parts. We'd like a chance to solve some of your problems.

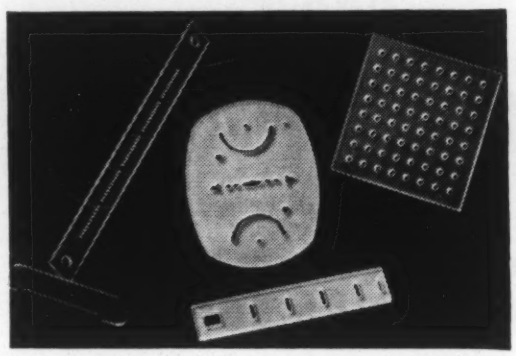
Wee

This 25 ml conical micro flask measures 75mm. in height. It has two necks, both ground to what is called a "standard taper," very accurate and smooth.

Such petite and precise PYREX brand glassware is fashioned from Corning's glass No. 7740. This glass is eminently practical in labs (and in many tough industrial applications) because it stands up to most acids and alkalies, doesn't cloud, even with distilled water. And it's bothered not a bit by high temperatures or thermal changes.

This microware flask is one of the more than 9,000 items (standard and custom) we make for labs. Much of it is highly intricate stuff that is hand-made by skilled lampworkers. The whole line is neatly detailed in a new, 358 page catalog, LG-1. If you're in a lab and haven't received your copy, send for one.

Also ask for Bulletin B-83, "Properties of Selected Commercial Glasses." All about 7740 and many other glasses; very good to have on file.



360,000 holes per square inch!

No problem at all, putting that many holes in that space, when we use FOTOFORM®, a glass that's "machined" by chemistry.

We start with a photosensitive glass (one of a number of very *special* types from Corning). Using a photographic negative of the pattern you want and an ultraviolet source, we make a contact print on the glass. Then heat to convert exposed areas into etchable glass. Next, treat with acid to dissolve out the etchable image, leaving the pattern you want. Further processing converts to the form of FOTOFORM best suited to your final application.

What's FOTOFORM good for? Making *ultra*-precise mechanical and electrical parts.

Such as? Fine mesh (600 line) screens, brush holders for digital converters, various kinds of substrates, printed circuits, attenuator plates, dielectric spacers . . . and lots more.

Experience so far indicates that FOTOFORM makes feasible patterns and parts that would be *impossible* or *impractical* by other methods.

Added incentive: There's *no* need for costly dies and jigs and you *eliminate* grinding, cutting, and drilling.

FOTOFORM is non-porous, dimensionally stable, free from internal flaws and voids, able to operate continuously at 500°C, and has zero moisture absorption.

Easily applied to small runs or mass production and well-suited to automation, it looks like a real contribution to many fields, especially electronics.

For more facts and figures ask for "New Developments in Corning FOTOFORM Glass." Check the coupon.

Attention photon counters

Now available from Corning is a new, high-lead-content glass for use in Cerenkov counters. A crystal clear glass with a specific gravity of 4.63, it permits better energy resolution than any glass currently used with this type of spectrometer.

Designated code 9766, it has an index of refraction of 1.724 and a transmittance of 82.8% at 400 Ä for 10 radiation lengths. Send for detailed fact sheets or other data you desire. *Corning can do almost anything with glass.*

Corning means research in Glass

CORNING GLASS WORKS, 50-6 Crystal Street, Corning, New York

Please send me: ☐ Bulletin on FOTOFORM; ☐ Lab Glassware Catalog, LG-1; ☐ Bulletin B-83, "Properties of Selected Commercial Glasses"; ☐ Data on high lead glass.

Name..... Title.....

Company.....

Street.....

City..... Zone..... State.....

For more information, turn to Reader Service card, circle No. 541

PROTECTING JET ENGINE PARTS with Sicon Silicone Coating

Allison J-35 A-35 assembly of Solar-built parts. SICON is used as a protective coating on combustion chambers, aft-frames, other jet engine parts, and afterburners.

Operator masks end of combustion chamber with simple cardboard shields as he applies SICON finish to resist temperatures up to 800°F.

This J-35 afterburner shroud assembly has been masked at critical hole patterns and threaded attachments before being sprayed with SICON silicone coating.

HEAT RESISTANCE UP TO 800°F. *plus* EASY APPLICATION

An example of how SICON solves Finish Problems for Design Engineers.

Jet engine parts made by Solar Aircraft are fabricated from special aluminized steel to meet conditions of extremely high temperatures. Certain welding operations destroy the aluminized surface, and at such critical points SICON was first adopted as a touch-up finish to renew vital protection needed. SICON proved stable under searing heat tests due to its strong film adhesion and excellent heat resistance characteristics, also so easy and fast to apply that many parts are now given an all-over SICON coating.

Rigorous heat tests have proved SICON best for many other products such as automobile manifolds, exhaust pipes, furnaces, and heaters. SICON is easy to apply, by brush, spray, or dip, to any chemically clean surface; and in many cases can be either air-dried or baked.

Decorative colors for lower temperature needs—whites, beiges, tans, and other shades, all with excellent retention of color and gloss in the 550°F. range, are now available.

Write us about your problem. If a SICON formulation is indicated we will provide a sample based on color and temperature requirements. *Dept. F-1*

MIDLAND *Industrial Finishes Co.*

EAST WATER ST., WAUKEGAN, ILLINOIS

ENAMELS·SYNTHETICS·LACQUERS·VARNISHES

Sicon

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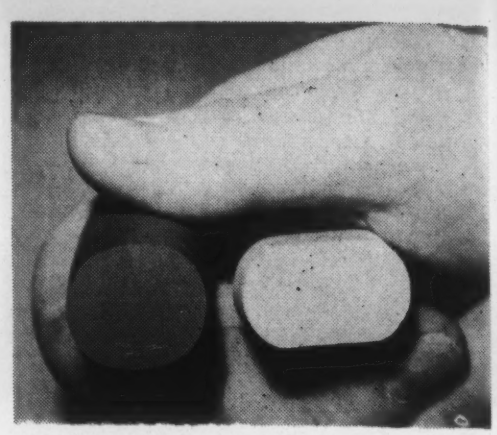
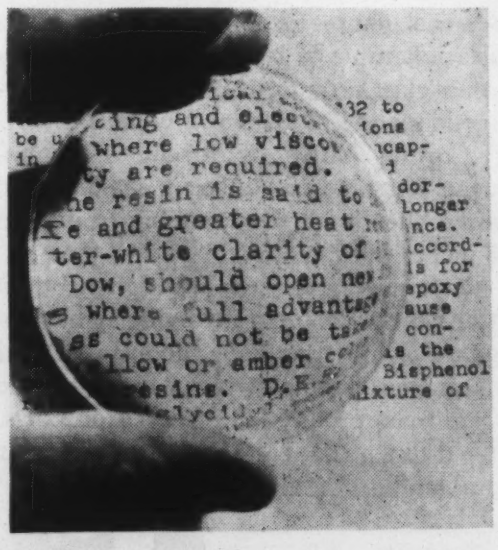
What's new IN MATERIALS



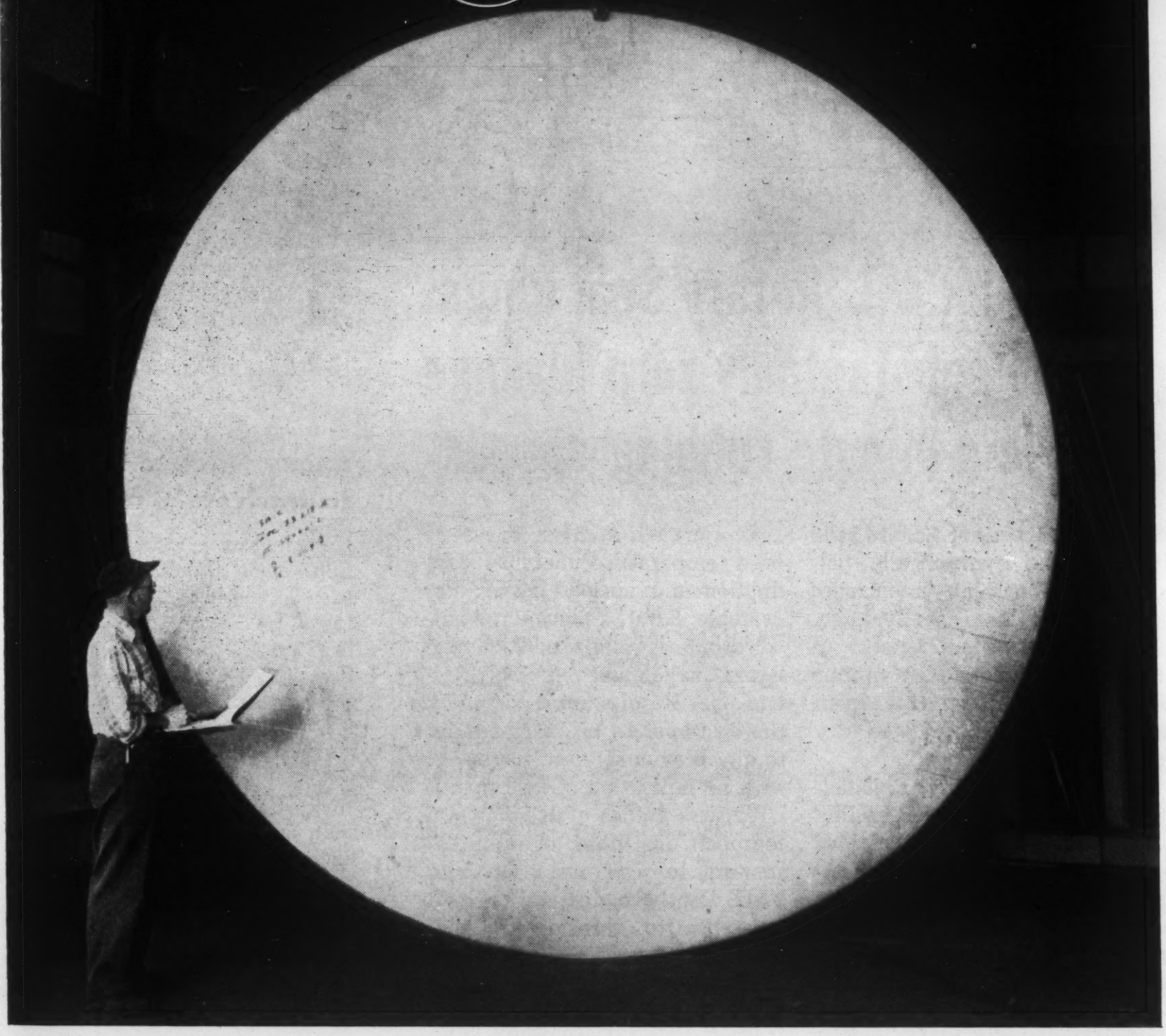
Compression set *of Dow's new silicone rubber (left) compared to that of regular silicone rubber (right). Both samples were compressed under 25% deflection for 22 hr at 480 F.*

tures than regular silicone rubbers has been announced by Dow Corning Corp., Midland, Mich. One of the compounds shows as little as 45% compression set after 22 hr at 480 F; regular silicone rubbers exhibit 100% compression set under the same



Clear epoxy—The water clear lens shown above is made of a newly developed epoxy resin just recently introduced by Dow Chemical Co. Called D.E.R. 332, the resin is one of three new epoxies available from the company. According to Dow, the resin is unique in that it is water clear, is extremely uniform, and has very low viscosity. It is recommended for use in tooling and electrical devices, paints, adhesives and reinforced plastics.

WHY BUY STAINLESS STEEL squares WHEN IT'S circles YOU NEED?



This circle, 9/16" thick x 164" diameter, is one piece of Type 316L stainless steel. Had the customer ordered a square, he would have paid freight on a half-ton of excess material. Also, he would have had the problem and expense of handling the square and cutting the circle.

Here are four sound reasons why Carlson customers save time and money when they order the circles they want—rather than the squares they have to cut . . .

1. If the gauge and size are circle-shearable, there is no extra charge for cutting the circle. This saves cutting labor and scrap handling expense.
2. If the gauge is such that a cutting charge applies to the square, it pays to order the circle. This eliminates the extra charge for cutting the original square and involves only the one charge for cutting the circle.
3. Because circles weigh approximately 25% less than squares, there's a substantial saving in transportation costs.
4. Small or medium size circles are often available from stock when squares may not be. The delivery time saved can be an important factor.

When you need stainless steel circles, come to Carlson where we specialize in stainless steel . . . that's your guarantee of dependable service.

Stainless Steels Exclusively

G. O. CARLSON Inc.

THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

Plates • Plate Products • Forgings • Bars • Sheets (No. 1 Finish)

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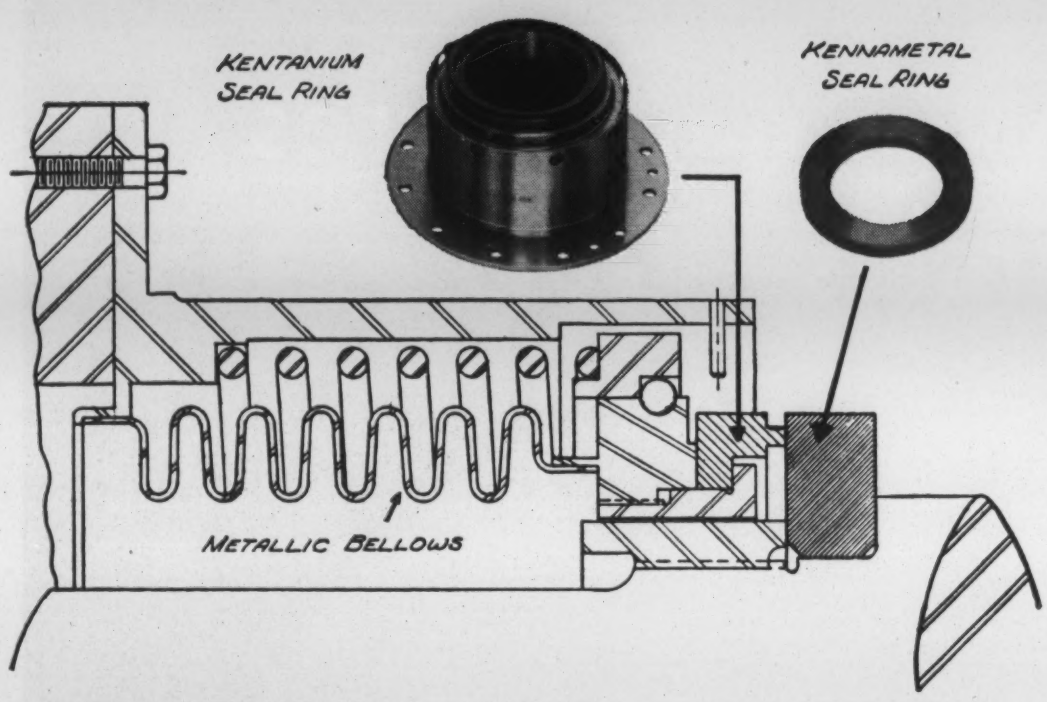


KENNAMETAL* Rotary Seal Rings provide substantially zero leakage at mile-a-minute rubbing speeds

At rubbing speeds of 4200 to 5400 ft./min., the hydraulically balanced seal shown above achieves substantially zero gas leakage. Excellent wear characteristics of the Kennametal and Kentanium* Seal Rings featured in this design make possible unlubricated dry rubbing at peak speeds.

Stein Seal Company, Philadelphia, Pa., solved major sealing problems on many applications by using Kennametal and Kentanium parts in their hydraulic balanced seal design such as illustrated above. By using rings made of these hard carbide, wear-resistant compositions, it is possible to operate with higher spring forces and in much higher temperatures than when rings of conventional sealing materials are used.

The outstanding physical properties of Kennametal compositions have provided many more answers to rotary seal ring problems in the fields of petroleum refining and transportation, high-pressure high-temperature chemical production and nuclear power. For example, K501, a platinum-bonded carbide, is being used to confine liquid oxygen and red fuming nitric acid. Results are reported by the customer to be "far superior to any previously-used materials, with no indication of face wear."

Various grades of Kennametal compositions hold economical answers to *your* need for high YME, low thermal expansion, high resistance to abrasion, erosion, corrosion, impact and pressures. For positive sealing, with little or no maintenance, mating surfaces of Kennametal Seal Rings can be lapped to a flatness less than two light bands, with a surface finish better than two microinch.

For more information, send for Booklet B-111A, "Characteristics of Kennametal." Write to Dept. MDE, KENNAMETAL INC., Latrobe, Pennsylvania.

*Trademark

3151

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

INDUSTRY AND KENNAMETAL ...Partners in Progress

For more information, turn to Reader Service card, circle No. 378

What's new IN MATERIALS

conditions of aging.

Currently, three different stocks in the new series are being produced in pilot plant quantities. Identified as Silastic S-2096U, S-2097U and S-2098U, they are 60, 70 and 80 durometer, (Shore A hardness) respectively. All three have a serviceable temperature range from –70 to 500 F. Dow Corning says the compounds were developed to meet the need for more reliable oil seals, o-rings and gasketing materials in automotive, appliance, aircraft and military parts.

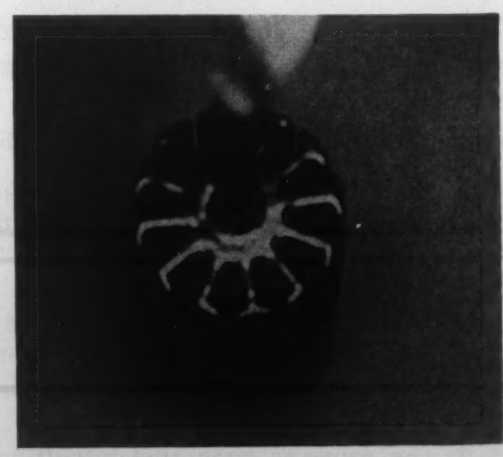
Epoxy Powder Fuses to Intricate Shapes

A one-part epoxy resin powder called Scotchcast No. XR-5005 has been developed by Minnesota Mining & Mfg. Co., 900 Bush St., St. Paul 6, Minn. for fusion coating of such electrical parts as coils, capacitors, armatures, rotors, printed circuits, bus bars and stators.

The cured resin is said to have good dielectric strength (more than 500 v per mil), high heat distortion point, low moisture absorption and good impact strength.

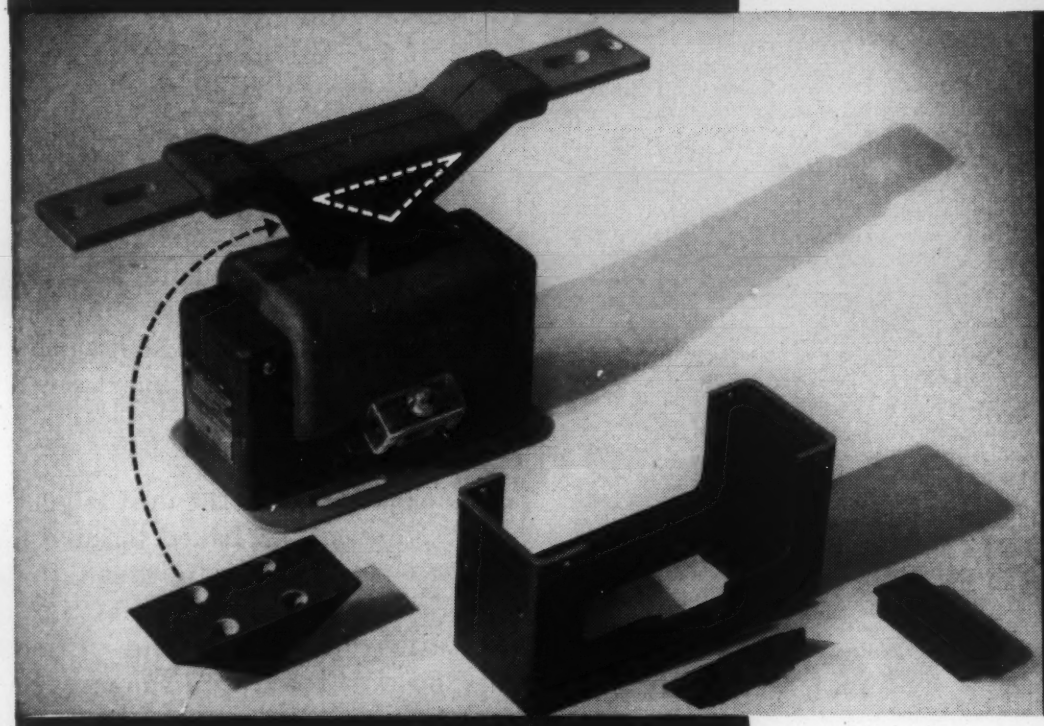
How coating is applied

The epoxy coating is applied in a fluidized coating process similar to National Polymer Product's



***Preheated rotor** is dipped into 3M's aerated epoxy resin powder where it is fusion coated.*

Design for LONG SERVICE LIFE–



molded reinforced polyester adds electro-mechanical strength, high insulation value

The new line of Westinghouse current transformers for indoor metering or relaying applications is smaller and approximately 20% lighter than ever before—yet has a rating factor of 1.5 overload, continuous operation.

Five molded reinforced polyester pieces by the Carl Zehr Company, Ashtabula, Ohio, contribute to the electrical and mechanical strength, light weight, compactness and modern appearance of this new Westinghouse line.

The case, terminal block and end caps are molded of Atlac Thermaflow 2400. Strong and light, this assembly has eliminated welding and strapping operations, thus facilitating assembly, and completely protects the coils from mechanical damage.

The "V" shaped block which acts as a spacer and fastening block for the primary terminals is of Atlac Thermaflow 500, a high-strength electrical grade material. Westinghouse insists on—and gets—full mechanical strength after exposure to 240°C. for one hour.

A variety of glass and nylon rag reinforced Atlac Thermaflow compounds are available to suit your specific material needs. Write for the new catalog.

Data for designers

Atlac Thermaflow 500

Impact strength (Izod, notch)	10-16 ft. lb./in.
Flexural strength	18,000—23,000 psi.
Compressive strength	21,000 psi.
Tensile strength	5,000—9,000 psi.
Mod. of elasticity	1.9 x 10^6 psi.
Heat distortion, 264 psi	over 500° F

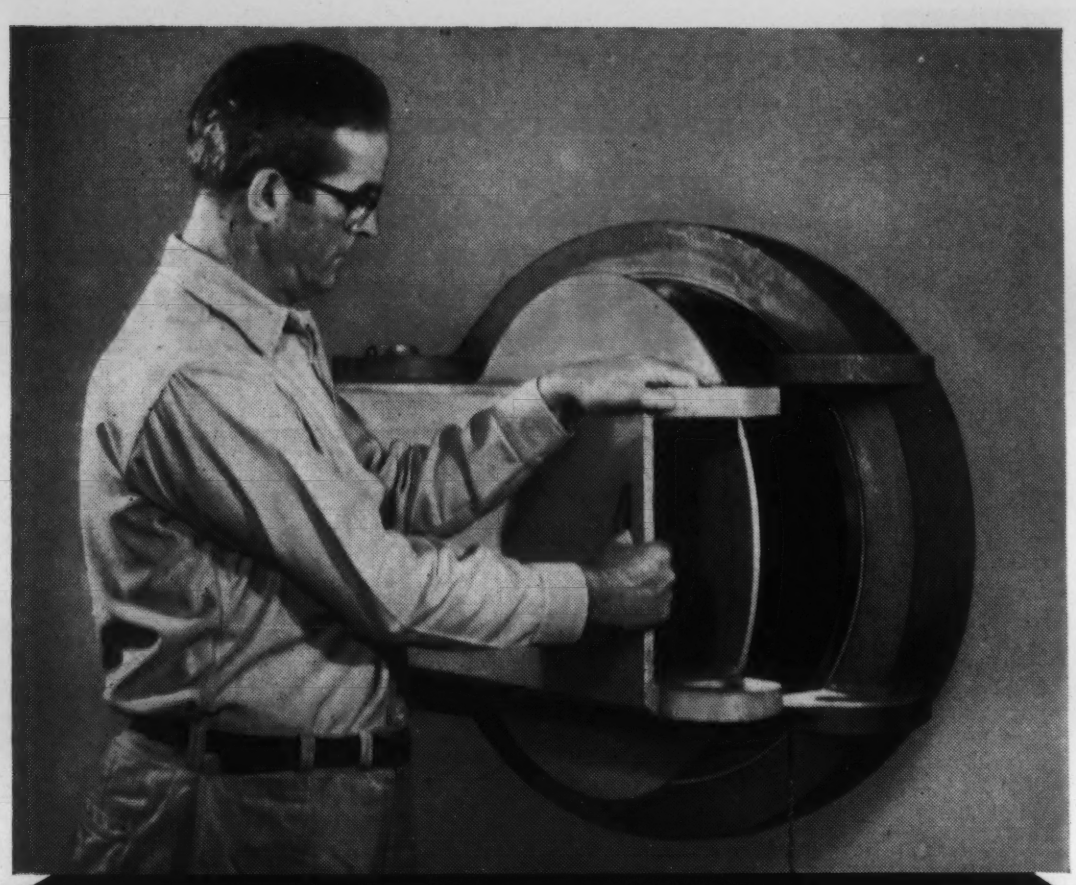
For data on all Atlac Thermaflow materials, write for a copy of our new catalog.

ATLAC THERMAFLOW

ATLAS

ATLAS POWDER COMPANY
Chemicals Division
Wilmington 99, Delaware

For more information, turn to Reader Service card, circle No. 549



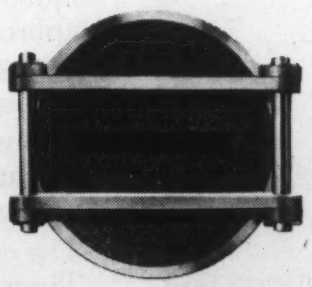
QUICK OPENING · TIGHT SEALING

the LENAPE-LACY MANWAY

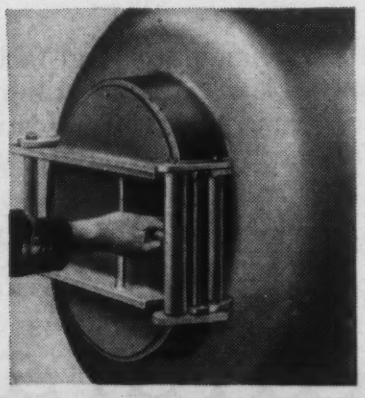
Remove One Pin — and Swing It Open
Close — Drop the Pin in Place — It's Sealed

Here is a manway that anyone can open in a few seconds without tools — yet can't open accidentally. Exclusive Lenape-Lacy design also *provides positive sealing* which seats more tightly with increasing pressure; and the molded gasket of Hycar or silicone rubber can be removed easily and quickly replaced. A protective lip shields the gasket seat from damage.

Three frame styles are available for all normal mounting conditions in ID sizes of 8", 12", 16", 18", 20", 24", and 30" in service ratings of 150 lbs., 300 lbs., 400 lbs., and 500 lbs. Also available for pressure-vacuum cycle service.



Opens in either direction. Other pin acts as a hinge.



For low pressure service, the Lenape-Lacy Latch-Door Manway is widely used. This design employs a unique, quick-opening camlock that permits safe venting of residual pressure before the door is opened. Stocked in 18" ID, 50 psi, plain straight ring frame; also furnished in 16", 18" and 20" 150 psi sizes on any style frame.

Write today for six page Bulletin 576 which describes Lenape-Lacy Quick Opening Manways including complete specifications.

See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

LENAPE PRESSURE VESSEL CONNECTIONS

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 112 WEST CHESTER, PA.
RED MAN PRODUCTS

For more information, turn to Reader Service card, circle No. 480

What's new IN MATERIALS

Whirlclad process (see MATERIALS & METHODS, June '55, p 92, and M/DE, Apr '58, p 200).

In the fluidized coating process, parts to be coated are heated to 200 to 400 F (depending on the unit) and dipped into a fluidized bed of dry coating powders. The heat of the unit melts the resin surrounding it, causing a layer of resin to cling to it. The thickness of the coating can be controlled by temperature of the dipped unit or by the number of dips and re-heatings.

After coating, the unit is placed in an oven and baked to cure the epoxy resin and to cause it to flow into any tiny voids left in the coating during the dip. Curing time for the resin ranges from 5-10 min at 350 F to 1-2 hr at 250 F.

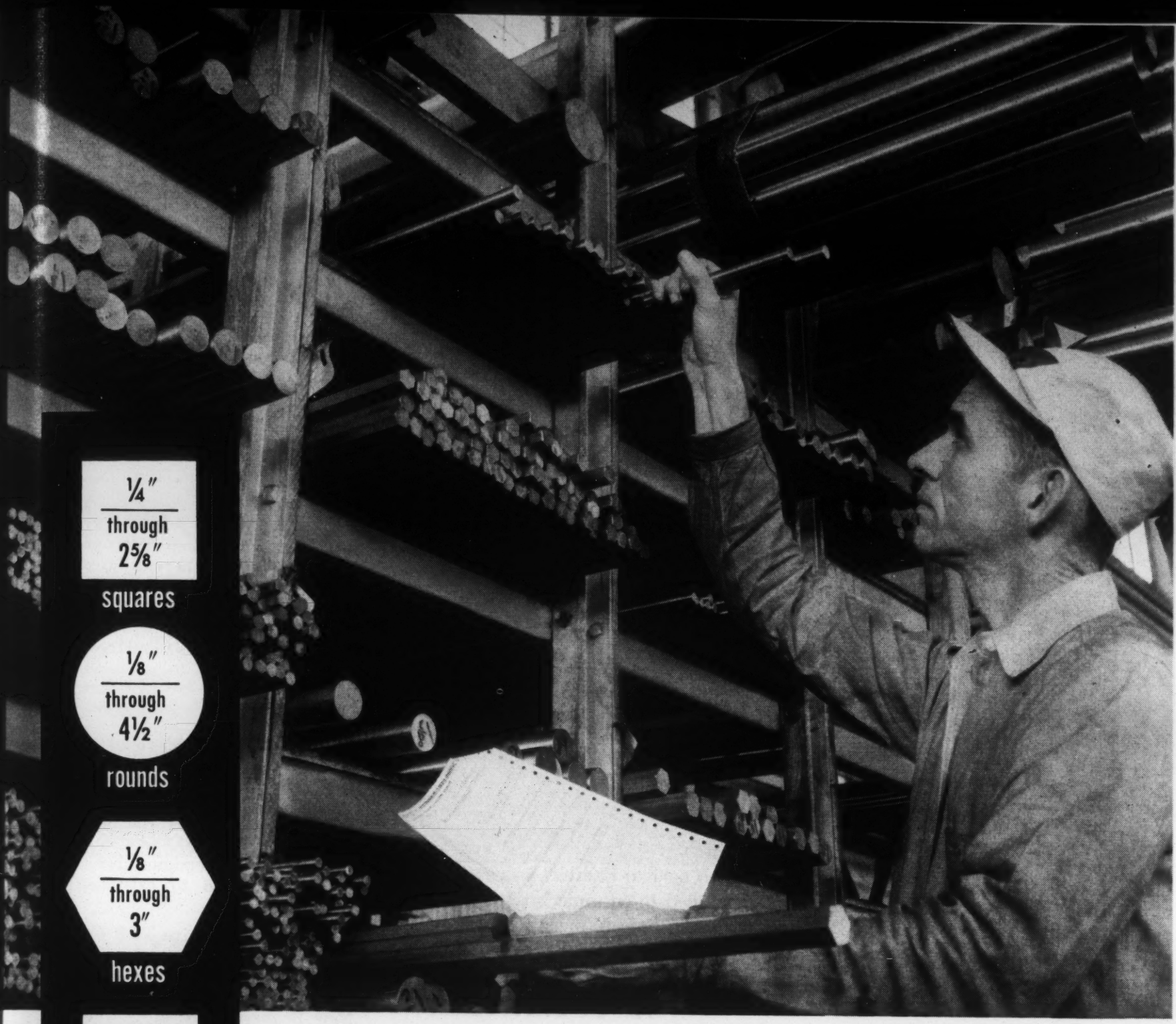
Filled Phenolic Has Good Impact Strength

Durez 18683 is the name given by Durez Plastics Div., Hooker Electrochemical Co., North Tonawanda, N. Y., to its new cellulose and mineral-filled phenolic molding compound. The company says parts molded from the compound have good dimensional stability, impact strength of 1.4 ft-lb per in. and good resistance to high

PROPERTIES OF DUREZ 18683

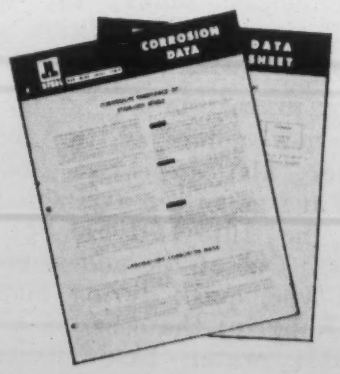
PHYSICAL PROPERTIES	
Tensile Strength, psi[a]	5500
Compressive Strength, psi[a]	25,000
Flexural Strength, psi[a]	8500
Heat Distortion Point (264 psi), F	270
Rockwell Hardness	M105
Water Absorption, %	0.9
Specific Gravity	1.42
ELECTRICAL PROPERTIES	
Dielectric Strength, v/mil	
Short-Time[b]	225
Step-by-Step[b]	200
Volume Resistivity, ohm-cm[a]	1×10^{12}
Dissipation Factor (60 cps)[a]	0.17
Dielectric Constant (60 cps)[a]	8.5

[a]Aged 48 hr at 120 F.
[b]Aged 48 hr in 50% RH at 75 F.



Steel Service Centers are served better from J & L's Master Stock of Stainless Steel

To better serve its warehouse customers, J & L's Stainless Steel Division in Detroit master stocks hundreds of tons of finished stainless steel bar and wire for prompt delivery. This stainless steel bar and wire stock is available in sizes and shapes to meet customer requirements and specifications.



Write for these Technical Data:
1. Laboratory Corrosion Data.
2. Data Sheets, (please specify the grades in which you are interested).

Improve your Products with . . .
J&L STEEL STAINLESS
BAR • WIRE • SHEET • STRIP

Jones & Laughlin Steel Corporation • STAINLESS STEEL DIVISION • Box 4606, Detroit 34

For more information, turn to Reader Service card, circle No. 495

only 2,215* rejects
OUT OF
314,249
Molybdenum
Parts

FANSTEEL

SETS AMAZING RECORD
IN TURNING OUT COMPLETE JOB
FROM POWDER TO FINISHED PART

*...and over 50% of the rejects were salvaged.

This outstanding production story is another good example of why so many manufacturers now say to Fansteel:

. . . "determine the *right* metal for our job
. . . make the metal
. . . and fabricate the parts to our specifications."

Actual dollar and cents savings over the last 4½ years has proved to this customer that turning the entire job over to Fansteel was a profitable move. Over 310,000 parts, machined to customer's rigid specifications, were delivered as needed and on time to meet production schedules...rejects and scrap were no longer a costly problem...breakage in subsequent broaching operations was practically eliminated . . . and customer's machines and personnel were available for other work.

To the customer, all of these benefits added up to the lowest possible FINAL COST-PER-PIECE.

INVESTIGATE the possibilities of similar savings in the production of some of your component parts. Get the combined consulting services of Fansteel metallurgists and our production engineers —the men who know how to make the metal as well as machine and fabricate it.

•

This story is typical of the news and technical comment contained in our publication, FANSTEEL METALLURGY. *Write, if you would like to receive a free copy regularly.*

15 OPERATIONS

1. Cut off rod
2. Centerless ground
3. Heat treat
4. 100% inspection—material and roundness
5. Center hole drilled
6. One end faced and chamfered
7. Bored to finish dimension
8. Other end is faced
9. Shoulders turned
10. Degreased and inspected for dimensions
11. Roll threaded to a class 3 fit
12. Faced to final length
13. Slot ground
14. Deburred
15. Final inspection for concentricity, all dimensions and finish

Tolerances: ± .0005
Concentric with thread pitch dia. within .002 T.I.R.
Finish: 16 Micro Inches

K585A

FANSTEEL®

TANTALUM • COLUMBIUM • CARBIDES • TUNGSTEN
TANTEL 77 METAL

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U. S. A.

For more information, turn to Reader Service card, circle No. 559

What's new IN MATERIALS

humidity. Durez 18683 has potential use in textile pulleys, oil well plugs, gas meter housings, terminal connectors and automotive heater housings.

Other News . . .

Ferrous metals

▸ A wrought iron called 4-D and produced by A. M. Byers Co., Clark Bldg., Pittsburgh, Pa., is said to have 25% greater resistance to corrosion than regular wrought iron. Samples of 4-D and regular wrought iron were exposed to a severe industrial atmosphere for 18 years.

Nonmetallics

▸ A new medium acrylonitrile rubber has been developed by Chemical Div., Goodyear Tire & Rubber Co., Akron 16, Ohio for use as seals, rings, gaskets, tubes and hose. According to the producer, the rubber, identified as Chemigum N8, is especially adapted to extrusion and calendering.

▸ A pressure sensitive TFE film tape called Permacel 422 and said to resist heat up to 500 F is now available from Permacel-Lepage's Inc., New Brunswick, N. J.

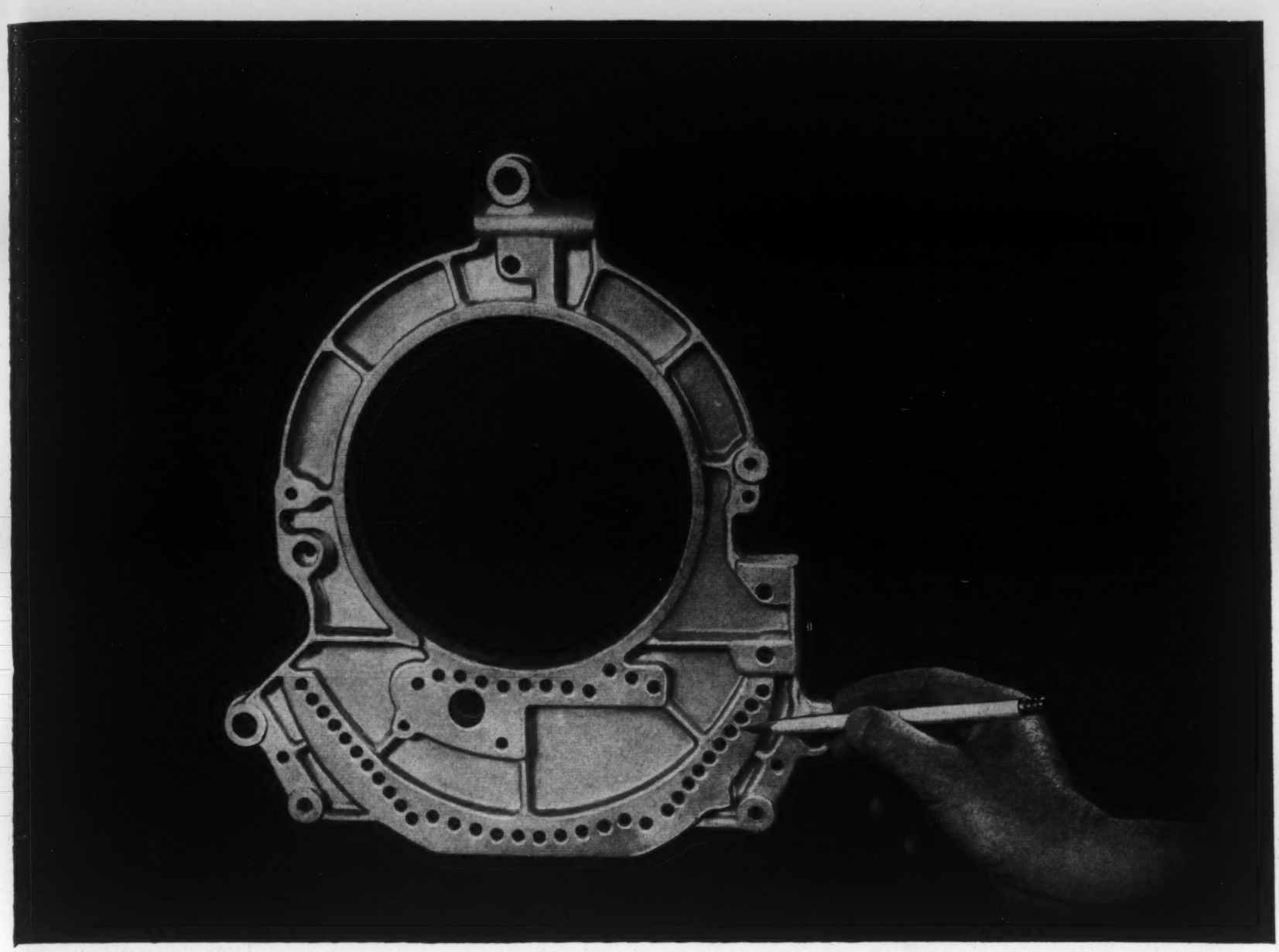
Finishes

▸ A new electroless process of plating high conductivity copper on ceramics directly out of solution has been developed by Radio Industries, Inc., 5225 N. Ravenswood Ave., Chicago 40. Known as Kemetal, the process is said to effect a close chemical bond between copper and ceramics.

▸ Two new brighteners for cyanide zinc plating solutions have been introduced by Allied Research Products, Inc., 4004-06 E. Monument St., Baltimore. One is ARP 32, a powdered addition agent for use in still and automatic tanks; the other, ARP 53, is a liquid addition agent for barrel plating operations.

Joining materials

▸ Two new adhesives for joining polyester film to wood, leather, fabrics and paper are available from Rubba, Inc., 1015 E. 173rd St., New York 60. One of the adhesives is a solvent-type, quick drying material called Rubgrip; the other is a nonflammable water-base dispersion called Rubtex.



The WHOLE Story Of Die Casting Savings

PARKER SALES ENGINEERS

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI 14, Ohio
William H. Broxterman • 2430 Central Parkway

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

LONG BEACH 11, California
R. W. Fletcher • 2803 Loomis Avenue

MINNEAPOLIS 16, Minn.
O. R. Kreutziger • 6524 Walker Street

PHOENIX, Arizona
Fred B. Larsen • 6108 North 11 Avenue

ST. LOUIS 8, Mo.
Frank May • 4378 Lindell Boulevard

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

WINTER PARK, Florida
Duane P. Davis • 110 South Orlando Avenue
Box 26

These close tolerance holes could have cost more than the part itself. Actually, *they cost practically nothing!* Parker-engineered die casting makes the difference. By means of precision coring, the holes are cast to exact diameter and location . . . a bonus in the low unit cost of producing the complete part. Just think of the savings compared with other production methods requiring finish machining.

The creative engineering approach that made these savings possible has been the hallmark of Parker service since 1906. It is the plus factor that is never figured into a Parker estimate. If you are a Parker customer, you know this is so. If you are not, you can profitably prove it to yourself by consulting the nearest Parker sales engineer on your next component part requirement.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure die castings in ALUMINUM • ZINC POWDERED METAL PARTS

For more information, turn to Reader Service card, circle No. 528

PLAST-IRON POWDERS

NEW

Grade B-280

Reduced • 80 Mesh

Improved Sponge Iron Powder

•

Complete Interchangeability For Present Dies

•

Competitively Designed

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Competitively Priced

PM 6d

Send for Technical Data and Working Sample

PM PLASTIC METALS

PLASTIC METALS

Division

National-U.S. Radiator Corporation

4458 BRIDGE STREET

JOHNSTOWN, PA.

For more information, circle No. 469

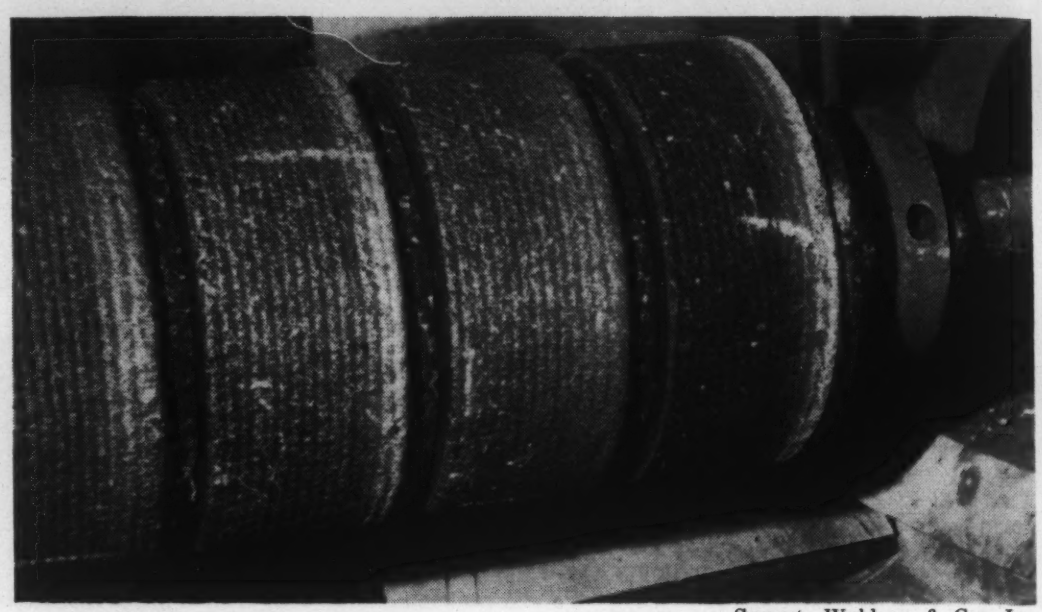
MATERIALS AT WORK

Nose cone—cont'd from p 12

holes drilled around the base are used for attachment on the instrument package.

To fabricate the nose cone, Lodge and Shipley Co.'s Floturn cold forming process was used. The photos on page 12 describe the procedure step by step from a 0.093 in. thick blank to cone.

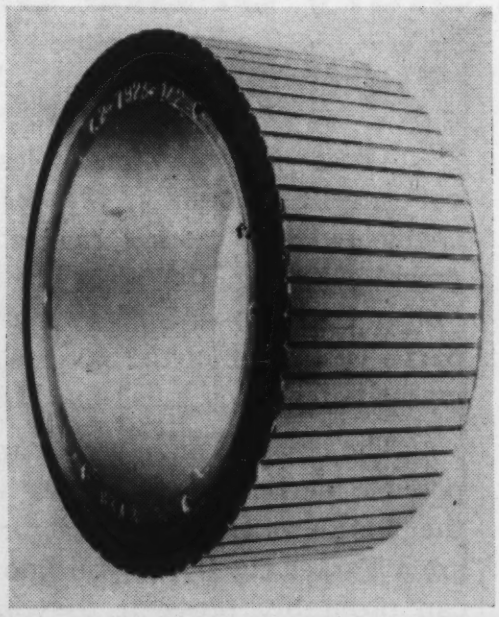
Carbide Provides Rough Surface



Sprout, Waldron & Co., Inc.

New roller.

Old roller.

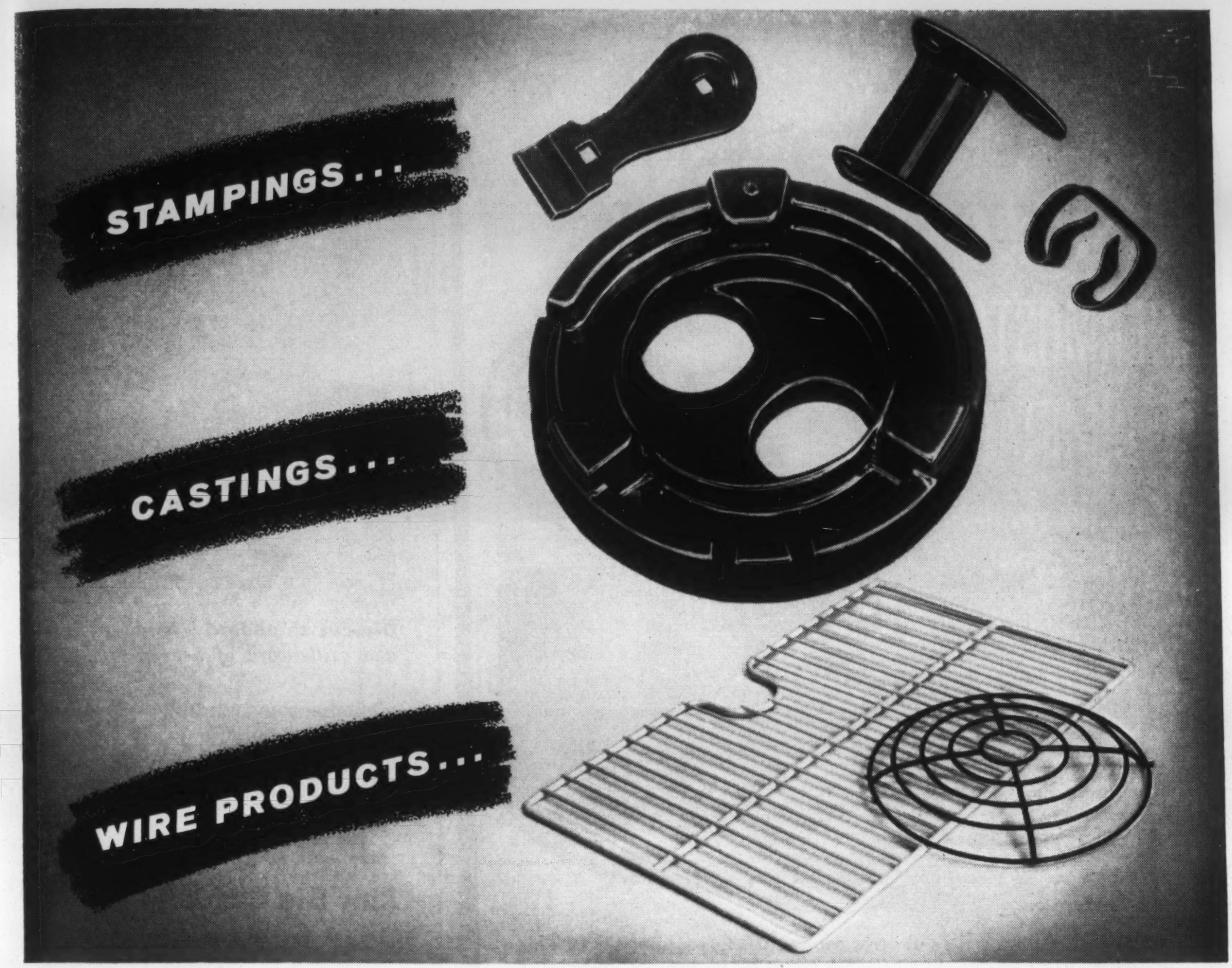


■ The replacement of grooved, hard surfaced steel with arc welded, granular tungsten carbide has resulted in a 50% cost saving in the production of rollers used in a pelletizing process.

The old rollers (left) were made by welding a ⅛-in. thick metal hard surface onto an annealed 1020 steel roller, then cutting 90-deg V-grooves in the periphery. The new rollers (above) are made by applying granular tungsten carbide on the steel surface by means of inert gas arc welding. This method provides a surface that is not only extremely rough (similar to that of a grinding wheel), but which has the added advantage of remaining rough throughout the life of the roller.

Chipboard Grille-Work Makes Filter Stronger

A new fiberglass air filter utilizing die-cut chipboard grille-work instead of metal stampings has been developed by the Fiber Glass Div., Pittsburgh Plate Glass Co. The filter, designed for heating, air conditioning and ventilating applications, is said to be stronger than previous designs because it has only two die-cut sections, with the ends firmly fastened to make



How many ways can you profit with new **CORVEL*** Fusion Bond Finishes?

No "ordinary" finish can match the challenging opportunities offered by CORVEL Cellulosic Finishing Powders.

CORVEL gives a premium appearance in beauty and controlled sheen—retains gloss and color. It assures uniform coverage even on sharp edges, corners, and projections. There's no worry about sag or drip marks, no bridging at intersections. And CORVEL finishes resist water, salt spray and sunlight—provide superior toughness, impact and abrasion resistance.

Parts can be clad uniformly in just one dip with thicknesses far exceeding those generally obtained with ordinary paints or enamels.

CORVEL finishes are applied by the WHIRLCLAD® Finishing Process. The heated object is dipped into a fluidized bed of CORVEL powders. The powders, which are in a state of "whirling suspension", assume flow characteristics similar to a liquid and bond by fusion to the part.

CORVEL Fusion Bond Finishes are resin powders of various types specially formulated for use with the WHIRLCLAD Finishing Process. This new production process for cladding metals and other materials with plastics is licensed exclusively in the U. S. and Canada by Polymer Processes, Inc., an affiliate company.

Write today for our new bulletin including data on all CORVEL Finishing Resins.

NATIONAL POLYMER PRODUCTS, INC. / Reading, Pa.

A subsidiary of The Polymer Corporation

**Polymer Corporation Trademark for finishing materials*

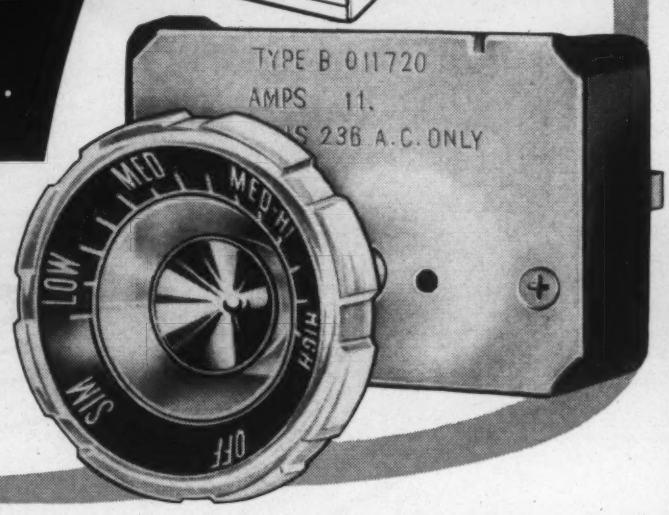
POLYPENCO®

For more information, turn to Reader Service card, circle No. 567

THE Westinghouse RANGE CONTROL SWITCH

Chace THERMOSTATIC BIMETAL

Actuates Another Precision Product . . .



A Product of Westinghouse Electric Corp., Electric Appliance Service Div., Mansfield, Ohio

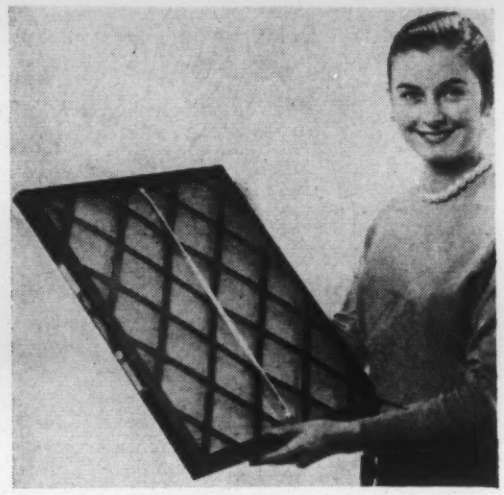
No more big "jumps" in electric range surface cooking heats. This Westinghouse Range Control Switch provides an infinite number of heats for all surface burners and is incorporated in the entire 1958 line of ranges. As many as four are used to control the average wattage delivered to each heater. This well-engineered and precision-manufactured product uses three thermostatic bimetal elements: the main operating element to open and close contacts; the differential element to introduce some temperature differential and thereby prevent contact fluttering; and the compensator element to give identical per cent inputs at all ambient temperatures.

We at Chace accept the heavy responsibility placed upon us by appliance manufacturers such as Westinghouse. For it is our duty—and our privilege—to provide dependable thermostatic bimetal for the countless actuating devices in the millions of appliances which help to make our lives safe, comfortable and worry-free. Thus these marvelous products can go to the far corners of the globe—and the automatic features actuated by Chace Thermostatic Bimetal will operate year after year with efficiency and a minimum of attention. In more than a third of a century as exclusive manufacturers of bimetal, we have learned that only a truly precision product can give completely reliable service.

So remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in over 30 types, in strip, coil or completely fabricated and assembled elements to your design. Write today for new 1958 booklet, "Successful Applications of Chace Thermostatic Bimetal", containing many pages of design data.

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 521



***Die-cut chipboard** is used for frame and grille-work of new filter.*

a single compact unit. The filter is also said to offer greater safety because the elimination of metal prevents hand and wrist cuts previously received.

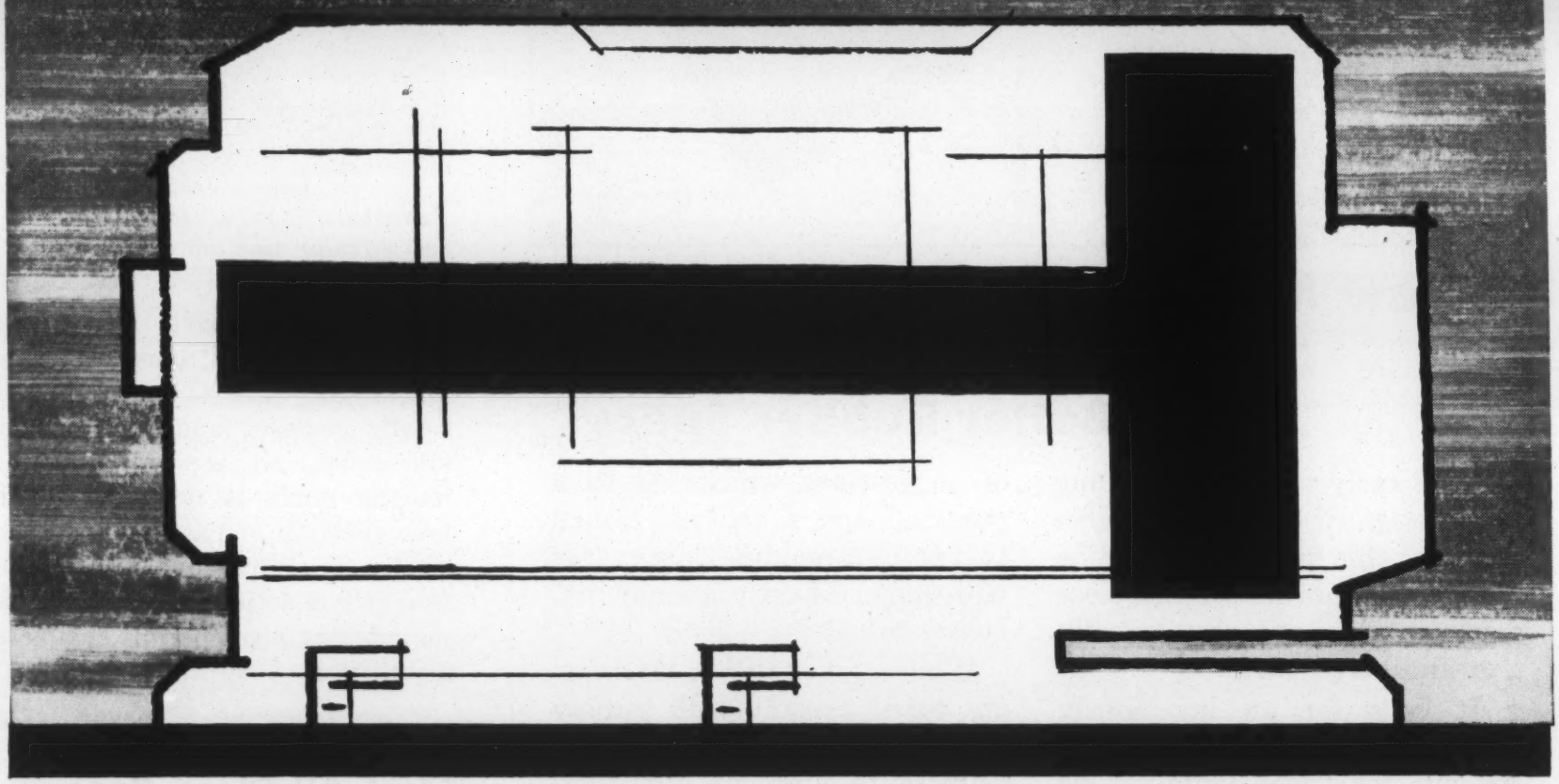
Zinc Die Castings Used in New Caster

In a complete departure from traditional methods of construction, Shepherd Casters, Inc. has come up with an entirely new furniture caster design based on two circular zinc die castings. As shown in the photo on page 192. casting *A* has a cored bearing on one side which accommodates an adapter pivot (for assembly to the furniture) and an integrally cast steel axle embedded in its center. The steel axle fits the cored bearing hole in the hub of casting *B*, and the entire unit is assembled by simply inserting a locking pin through holes machined in casting *A* (see arrows). The pin engages a channel in the adapter pivot and a machined channel in the hub of casting *B*.

Use of die castings minimizes

SOURCES of most engineering materials can be found in M/DE's *Materials Selector* reference issue, published last September. Properties of all materials are also given.

How billion-proved VALFORGINGS will help an alert pump manufacturer cut part costs 19%



By making a one-piece rotor and drive shaft from a single VALFORGING, a manufacturer of pumps will be able to reduce his cost per pump more than 26 cents a unit.

A Thompson VALFORGING is a hot-extruded steel forging whose head-to-shaft-diameter ratio is at least 1½ . . . a large head on a smaller shaft. Continuous grain flow at the neck provides higher strength at high stress points. Simple head features can also be coin-pressed into VALFORGINGS to eliminate several costly machining operations.

If you now make parts of this type by turning down overlarge rough forgings or expensive bar stock, you are generating high-cost scrap on high-burden machines with high-priced machinists. A VALFORGING comes to you forged to shape in any grade of steel you require.

Let us show you how VALFORGINGS can be made in sizes up to 5″ in head diameter, 12″ shaft length. Write to the address below.

Valve Division ***Thompson Products, Inc.***

DEPT. ME-658 • 1455 EAST 185th STREET • CLEVELAND 10, OHIO

©1958

For more information, turn to Reader Service card, circle No. 477

Courtesy Scott Aviation Corp.

New Molded Profile Reveals Techniques for Better Rubber Specs

In the early stage of planning and design, it was questionable whether this face mask could be molded in rubber—in one piece—practically, yet economically . . . and here's why.

It calls for an ingeniously designed and machined mold to provide for facial contours, air inlets and outlets, undercuts, feathered edges, valve mounts, fastenings, etc.—one of the hardest-to-fill cavities ever encountered. Also, the rubber must be compounded to flow freely inside this complicated form and still maintain its knitting qualities. How was this accomplished?

While the mask was still in the design stage the customer realized the importance of consulting a rubber specialist. From this conference came an exchange of suggestions which led to a practical and functional design that permits molding these masks with unusual speed and economy. Here's the idea.

While a job is still on the drawing board consult with rubber specialists. Suggestions can often be made to eliminate high tooling costs or high priced compounds. End results give you better rubber parts, better performance and lowest cost. Regardless of how simple or complex your rubber needs may be call Continental—specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1985 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 456

MATERIALS AT WORK

American Die Casting Institute

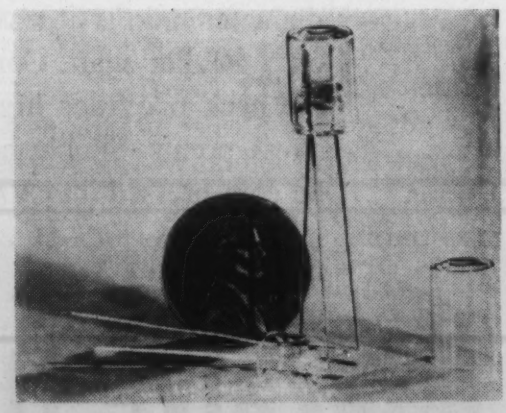
Furniture caster *is composed of two circular zinc die castings.*

the number of parts and avoids the necessity for more elaborate machining. Since the caster is totally enclosed and permanently lubricated, no messy oiling of moving parts is necessary. The free rotation of casting *B* on the steel axle in casting *A* and the free swivel action of casting *A* on the adapter pivot permit complete mobility in any direction.

First All-Glass Case for Transistor Units

A new, close-control electric sealing process has made possible the first all-glass transistor enclosure manufactured in the United States.

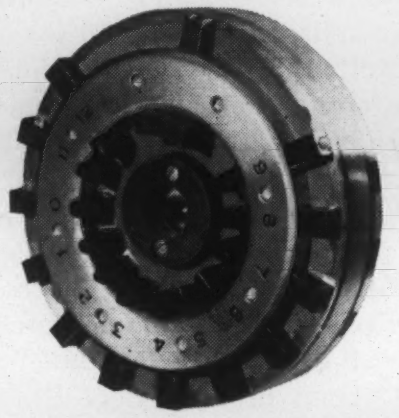
Complete details of the process



Transistor base *(left) is cased in thin-walled glass envelope (right) to form complete assembly.*

PRODUCT-DESIGN MEMOS FROM DUREZ

Moisture-stable insulation | **Parts for the DC-8** | **Electric motor shortcut**



International Business Machines Corporation

Insulation-plus

A good example of what can be done with *Durez 16694* diallyl phthalate is this plastic-and-metal commutator for an electronic card sorter.

The commutator acts as a cam contact to establish the timing of impulses which energize a sort magnet. It incorporates a metallic hub, brass plate, copper ring, and 12 terminal inserts.

The molding material that holds these parts in place must:

1. Resist arcing.
2. Pass a 1000-volt dielectric breakdown test in high-temperature high-humidity conditions.
3. Retain high dimensional stability at 90°C and 90% relative humidity.
4. Possess wear characteristics that lead to maximum commutator and brush life.

Durez 16694 meets these requirements, and also provides critical dimensional accuracy between the terminals and the brass plate.

Its ability to do so suggests that you consider it for similar electrical jobs. It's the only type of plastic that retains high insulation values over extended periods at relative humidities above 90%. Its arc resistance, as measured by ASTM D495 (Method A or B) can be consistently reproduced. It does not corrode metal contact points, and is virtually free from cold flow and creep.

For a data sheet detailing properties of *Durez 16694* and of molded material, check the coupon.

Jet-propelled plastic

Streaking through the stratosphere nearly eight miles up, the Douglas DC-8 jetliner will bring new ease and convenience to air travel.

Passengers on the huge jet transport will relax in controlled climate provided by a system that changes cabin air every three minutes. Flight officers will scan their instruments by softly diffused light from a ceiling panel. In both instances, *Hetron*® 92 polyester will be helping to set the new pace in jet-age flight comfort. This Durez material, reinforced with fibrous glass, is specified for the DC-8's cabin ventilation ducts and cockpit light-diffuser panel.

Hetron 92 will also help to shade crewman's eyes against sun glare. The cockpit glare shield, above the plane's instrument panel, is made from glass-reinforced Hetron laminated with a core of cellular cellulose acetate.

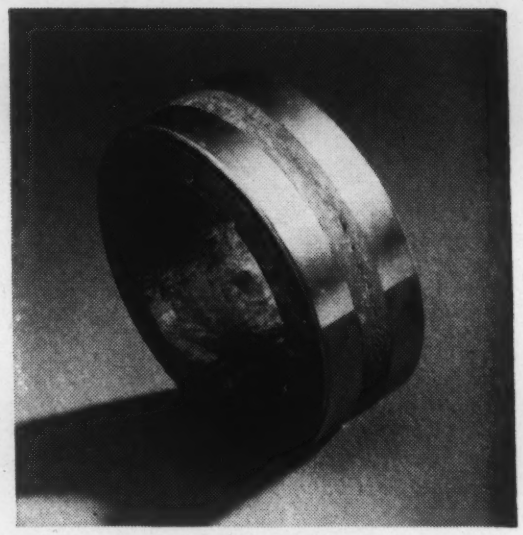
Douglas uses Hetron also in the ailerons and wing-tip trailing edges of DC-6 and DC-7 series airliners, precursors of the DC-8. Hetron is specified because of its combination of strength and inherent fire retardance. It is permanently self-extinguishing without additives.

Douglas Aircraft Company, Inc.

There's a whole family of Hetron resins to give you the properties you need in structural parts—for an aileron or an outboard boat; for radomes or railroad cars; housings or heater ducts; fenders or fume hoods. To see how these self-extinguishing polyesters match up to your requirements, check the coupon for a complete Hetron data file.

Cost cutter

Looking for a lower-cost way to make an electric motor or generator? A commutator ring like this could be your answer.



Notice how snugly the metal contact rings fit the tough plastic base. It's almost impossible to pry them loose. Dirt or moisture can't get underneath to cause arcing, because the rings are molded in one solid component—not assembled.

You don't have to machine these commutator rings, either. They fit standard-size tubing—and fit it tightly so there's no vibration or motor noise.

These rugged rings are molded of *Durez 16771*, a high-impact glass-fiber-reinforced phenolic. This material stands heat up to 600°F. without distortion. Its dielectric strength, as measured by ASTM D149 (48 hours, 50% R.H., 23°C.) is 400 v/mil short time, 300 v/mil step by step.

If you see an opportunity in these rings, write to the molder, Norco Plastics, Inc., 3888 North Fratney St., Milwaukee 12, Wis. For data on the Durez compound with which they are made, just check the coupon.

For more information on Durez materials mentioned above, check here:

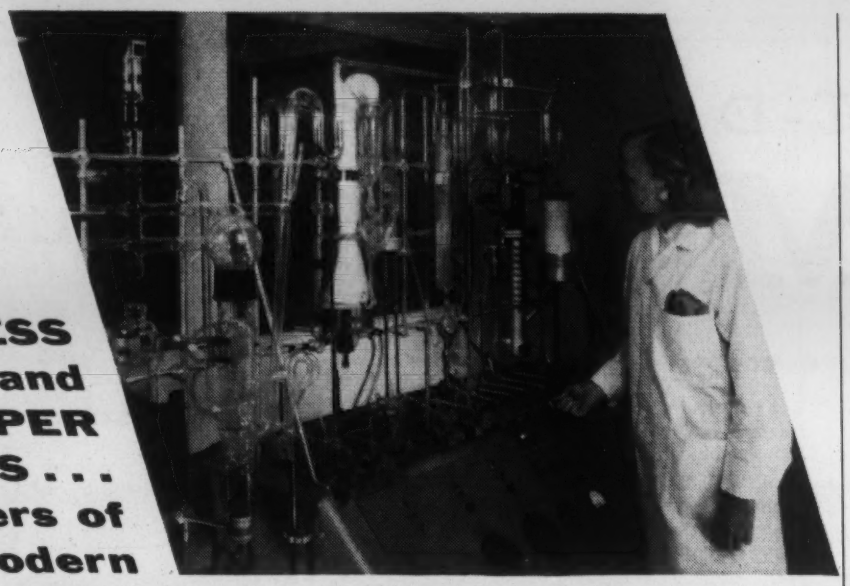
- ☐ Diallyl phthalate, 16694
- ☐ Hetron resins—technical data file
- ☐ High-impact phenolic, Durez 16771

Clip and mail to us with your name, title, company address. (When requesting samples, please use business letterhead.)

DUREZ® HOOKER CHEMICALS PLASTICS

PLASTICS DIVISION
HOOKER ELECTROCHEMICAL COMPANY
1406 Walck Road, North Tonawanda, N. Y.

For more information, turn to Reader Service card, circle No. 504



STAINLESS STEEL and SUPER METALS . . . workers of modern

miracles

Stainless steel and super metals have so many desirable characteristics — corrosion resistance, strength, hardness, beauty, workability — they are often termed "miracle metals." But they can perform miracles *only if you select the right analysis for your particular application.* Wallingford is more qualified than ever to help you do this. Now, an all-new metallurgical laboratory and a larger staff of expert technicians are at your service.

In such fields as nucleonics, aviation and guided missiles, stainless steel and super metals will accomplish miracles *only when gages can be held to the close tolerances demanded.* Wallingford's Sendzimir Mills, equipped with non-contacting, continuous gages, assure this. A feed-back system provides fully automatic correction of the mills to maintain strip thickness with required tolerances at all times. These mills make Wallingford one of the few companies capable of producing precision strip in widths up to 27" and as thin as .001" . . . and give Wallingford the largest foil capacity in the country.

Investigate Wallingford's ability to provide stainless steel and super metals that will perform "miracles."

THE WALLINGFORD STEEL CO.

Progress in Metals for over 36 Years

WALLINGFORD, CONN., U.S.A.

COLD ROLLED STRIP: Super Metals, Stainless, Alloy

WELDED TUBES AND PIPE: Super Metals, Stainless, Alloy

For more information, turn to Reader Service card, circle No. 442

have not been revealed. However, Corning Glass Works says that although the base and envelope are hermetically sealed at 1832 F, the temperature near the semiconductor (less than ¼ in. away) is kept below 230 F. Sealing is accomplished in about 10 sec.

Both the base and envelope of the circle enclosure are made of high purity, thin-walled, precision glass tubing. According to the company, the new enclosure is ". . . the first major advance in glass encapsulation for electronic devices since the development of the all-glass television tube."

Current production of the new transistor case is limited to the 200-mil lead circle type for low power units. Other sizes are expected to be available soon.

Giant phenolic duct—Shown above is one section of a fume duct system made entirely of plastics. This entrance hood, 7 ft high with a 6-ft throat section, is fabricated completely of acid-digested-asbestos-filled phenolic resin. It was produced to handle corrosive fumes given off during metal refining operations. According to Haveg Industries, Inc., this material was selected because of its high strength and rigidity and excellent resistance to corrosion.

For more information, circle No. 472 ➤

HOW THE SILICONES MAN HELPED...

ADD MUSCLE TO THE BRAWN THAT LIFTS A BUCKET OF STEEL

THREE HUNDRED tons of molten steel handled like a cup of tea. That's power with something to spare. But increases in production, the demand to do more work with small, compact equipment keeps electric motor design engineers on their toes.

The Elliott Company of Jeannette, Pa. is one of the leading suppliers of electric motors for steel mill applications. Recently, Elliott engineers wanted to increase overload capacity, life span, and resistance to corrosive atmospheres. They decided to use Class H insulation, and asked the Silicones Man to supply the necessary silicones. The result? A complete line of Class H mill motors with an expected life *ten times* that of present types! It's just one more example of how the specialized knowledge of the Silicones Man has helped solve an "impossible" problem.

Find out the latest information on silicones for Class H insulation or any of the other silicone products that solve problems of heat, cold, strength, corrosion. Call your Silicones Man, or address Dept. FM-6706, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. (*In Canada:* Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7, Ontario.)

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

The term "Union Carbide" is a registered trade-mark of UCC.

UNION CARBIDE TRADE-MARK SILICONES

"From the looks of that finger I think it's time you checked with H & H about their one-call-for-all service."

Expect the BEST brass and copper products from

H & H TUBE AND MANUFACTURING CO.

252 *N. Forman Avenue, Detroit 17, Michigan • Offices from Coast to Coast*

You save time, energy and needless purchasing expense by using H & H one-call-for-all service. Aside from providing its customers with brass and copper tubing and parts for almost any purpose, H & H can also furnish you with fabricated parts in aluminum and steel. So if you are not now enjoying the benefits of a truly *versatile* and *dependable* parts and tubing source, isn't it time you checked with H & H?

METALFLO LOCKSEAM COIL STRIP SEAMLESS TUBING TUBULAR PARTS

For more information, turn to Reader Service card, circle No. 494

PRICES AND SUPPLY

...AT A GLANCE

PRICE OF LEAD IS NOW THE LOWEST IT HAS BEEN IN FIVE YEARS. The latest reduction, 1¢ per lb, brings the New York price to 12¢ per lb. In May, 1957, the price was 16¢ per lb. Reasons given for the cut: mounting producers' stocks, decreased demand, and the announcement that . . .

. . . GOVERNMENT STOCKPILING OF LEAD WILL END JUNE 30. Since mid-1954 the Government had been accepting about 10,000 tons of zinc and 5000 tons of lead monthly. A decision by the Tariff Commission on requests for increased duties on the two metals is still pending. In the meantime . . .

. . . NEW LEGISLATION TO RESUME GOVERNMENT PURCHASE of copper, lead, zinc and manganese to prop these prices was recently introduced in the Senate. The legislation is in the form of an amendment to the domestic tungsten, asbestos, fluorospar and columbium-tantalum production and purchase act of 1956. Provisions of the amendment include the purchase of 1) 400,000 tons of refined electrolytic copper at 30¢ per lb; 2) 180,000 tons of common lead at 17¢ per lb; 3) 280,000 tons of slab zinc at 14½¢ per lb; and 4) 9,000,000 long tons of manganese. In addition, the bill would extend the asbestos, fluorospar and columbium-tantalum purchase program through 1959.

PRICE CUTS ON THREE INTERMEDIATE DENSITY POLYETHYLENE formulations have been made by Du Pont. Alathon 34, used for films and bottles, and Alathon 37, a general purpose molding compound, are now 37¢ per lb, down from 39¢. Alathon 31, a resin used for the extrusion of sheet for thermoforming, is now 39¢ per lb, down from 41¢. A new polyethylene formulation, Alathon 18, designed for molded plastics housewares has been increased from 32½ to 35¢ per lb.

PRODUCTION OF ALUMINUM DIE CASTINGS IN 1957 REACHED A NEW HIGH, according to the American Die Casting Institute. Total production amounted to 376,500,000 lb, or 2.5% more than the previous high registered in 1956.

HIGH DENSITY POLYETHYLENE PRODUCTION WILL INCREASE by 55 million pounds per year as a result of two new plants put into operation by Bakelite Co. At Institute, W. Va., Bakelite will produce 30 million pounds per year

of Ziegler-type polyethylene, and at Seadrift, Tex., Bakelite will produce 25 million pounds of Phillips-type polyethylene. This makes Bakelite the first company to produce both types of high density polyethylene.

FIRST ALUMINUM PRICE REDUCTION IN TEN YEARS was recently effected by all major producers: aluminum pig is now 24¢ per lb, down from 26¢. Reasons given for the reduction: greatly expanded productive facilities, declining consumer demand, users' reduction of inventories and "making the metal more competitive with other materials." Mill shapes, extrusions and some fabricated products were also reduced in price.

PRICE CUTS ON TWO GRADES OF DUCTILE TITANIUM METAL SPONGE have been made by Du Pont. A-1 Grade is now $2.05, down from $2.25, and A-2 Grade is now $1.85, down from $2.00. Price of A-2 Grade Fines remains unchanged at $1.65.

CONSUMPTION OF ISOCYANATES FOR PLASTICS FOAMS WILL INCREASE to about 40-50 million pounds per year by 1960, according to Joseph Marzak, National Aniline Div., Allied Chemical Corp. The 1958 figure is expected to reach 12 million pounds, or about twice that of 1956. Consumption of urethane foams should reach 28 million pounds in 1958 and as high as 70 million pounds by 1960, Mr. Marzak predicts.

PLATINUM PRICES CONTINUE TO FALL despite apparently stable "market prices." Officially, the price is quoted at $72 per oz.; however, New York dealers are selling the metal for as low as $67 per oz. In January, 1957, platinum was selling for $103 per oz.

THIRD DECREASE IN COPPER PRODUCTION IN ONLY FOUR MONTHS has been announced by Kennecott Copper Corp.—the largest U.S. producer. The latest reduction amounts to about about 3350 tons per month and will bring Kennecott's output rate down to 67% of the company's 1957 production, which amounted to 387,291 tons. The two previous curtailments totaled about 7300 tons per month.

NICKEL PRODUCTION CONTINUES TO OUTWEIGH CONSUMPTION, according to International Nickel Co. of Canada. As a result, the company has cut production by 10%, or about 1000 tons per month. A similar cut was effected in April.

ZINC PRODUCTION HAS BEEN CUT BY ABOUT 30% of capacity at New Jersey Zinc Co.'s smelting plants in Palmerton, Pa. and Depue, Ill. According to the company, the reductions were necessitated by "continued flooding of domestic markets with foreign zinc."

Prices of Materials

Changes since last quarterly report in March are bold-faced

NONMETALLICS

Prices for large quantities for range of grades, color, sizes; given in $/lb

RUBBER

Material	Dry	Latex
Butadiene-Acrylonitrile	.49-**.68**	.46-.54
Butadiene-Styrene	**.16**-.30	.22-.32
Butyl	**.22**-**.26**	—
Neoprene[a]	.39-.75	.37-.47
Silicone[a]	1.90-4	—
Polysulfide[a]	.47-1	.70-.92
Natural	.27	—

[a]Less than carload quantities.
[b]Average spot price for month of Apr.

GLASS FOR REINFORCED PLASTICS

Fabric ($/yd 38 in. wide)[a]	
112 Woven	.48
181 Long-shaft satin weave	1.03
143 Unidirectional	1.00
Roving[a]	
Continuous	.40
Continuous spun strand	.36
Continuous chopped spun	.38
Milled fibers (1/32-¼ in.)[a]	.45
Mat	
Chopped strand (2 in.)[a,b]	.52-.72
Surfacing ($/1000 sq ft)[c]	10-19
Continuous chopped strand (¼-2 in.)	.40

[a]Price includes binder or finish.
[b]Price varies with binder.
[c]0.010-0.020 in. thick.

THERMOSETTING PLASTICS

Material	Molding Compounds	Laminating, Casting Resins
Alkyd	.34-.53	—
Epoxy	—	.45-.80
Melamine	.42-.45	.40-.41
Phenolic	.21-.40	.17-.34
Polyester	.42	.32-.50
Silicone	2.75-5.40	1.55-1.74[a]
Urea	.19-.33	—

[a]60% solids content.

All prices are approximate and given solely for general guidance of those responsible for materials selection.

THERMOPLASTICS

Material	Molding Compounds	Sheet (.030-.250 in.)	Rod ⅛-¼ in.	Rod ⅜-1¼ in.	Tube ⅛-¼ in.	Tube ⅜-1¼ in.
Acrylic	.51-.59	.49-2.15	.90-1.15	.80-.90	1-1.15	.90-1
Cellulosic						
Acetate	.36-.65	.92-1.16	.75-1	.65-.75	.85-1	.75-.85
Butyrate	.40-.72	1-1.28	.95-1.20	.85-.95	1.05-1.20	.85-1.05
Nitrate	—	1.60-2.73	1.45-1.75		2.25-5.00	
Propionate	.51-.63	—	—		—	
Fluorocarbon						
CFE	7-8	15-23	18-22	14-20	20-22.50	16-20
TFE	4.50-7.45	14.30-11	13	13	13	13
Nylon	1.18-2.30	—	3	3	3	3
Polyethylene	.35-.56	.85-1	.75-1	.65-.75	.85-1	.75-.85
Polystyrene	.25-.44	.57-.61	.65-.90	.55-.65	.75-.90	.65-.75
Vinyl	.27-.43	.62-.92	.75-1	.65-.75	.85-1	.75-.85

NONFERROUS METALS

Mill base prices for large quantities; given in $/lb except where indicated

ALUMINUM

Pig (99-99.9%)	.24
Ingot (99-99.9%)	.26
Foil (5-0.5 mil)	.55-.77
Alloy Ingot (13, 43, A132, 214)	.28
Sheet (1100, 3003; 3-0.03 in.)[a]	.43-.47
Plate (1100, 3003, 5050, 3004, 5052)[a]	.42-.45

[a]Mill finish.

BRASS

Form	Cart., 70%	Low, 80%	Red, 85%
Sheet, Strip	.43	.45	.46
Seamless Tubing	.46	.48	.49
Rod (not f.c.)	.44	.45	.46
Wire	.43	.45	.46

COPPER

Ingot (elec)	.25
Sheet, Strip (hot rolled)	.48
Seamless Tubing	.48
Rod, Drawn	.45
Rod, Free Cutting	.57
Wire	
Round	.30
Square, Rectangular	.32
Magnet	.38

LEAD

Common Grade	.12

MAGNESIUM

Pig (98.8%)	.35-.36
Ingot (98.8%)	.36-.37
AZ91B Ingot (die casting)	.37
AZ91C Ingot (sand casting)	.41[a]

[a]Delivered price.

NICKEL

Form	"F"	"A"	Monel
Ingot	.75[a]	—	—
Rod	—	1.07	.89
Sheet, C.R.	—	1.26	1.06
Strip, C.R.	—	1.24	1.08
Seamless Tube	—	1.57	1.29

[a]Delivered price.

TIN

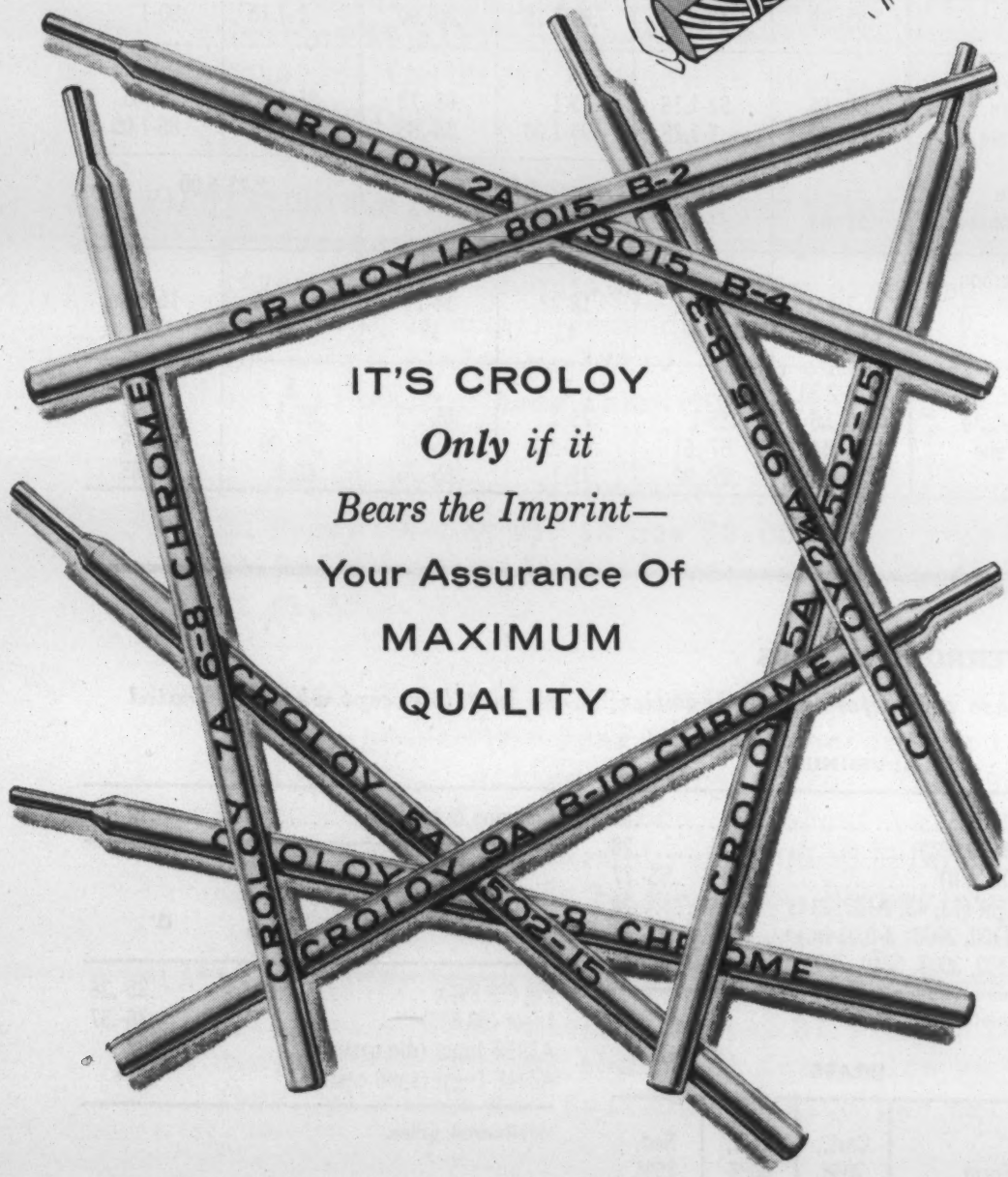
Primary[a]	.93

[a]Delivered price.

(continued on p 200)

For Top Quality Welding
On Chrome-Alloy Steels

Use CHAMPION CROLOY® ELECTRODES



IT'S CROLOY
Only if it
Bears the Imprint—
Your Assurance Of
MAXIMUM
QUALITY

For top drawer welding of Chrome Moly Steels, **Champion Croloy Electrodes** have excellent handling characteristics in all positions, and produce radiographically clean welds of unsurpassed mechanical properties. **Champion Croloy Electrodes** are available in all of the popular grades from 1¼% Chrome, ½% Moly to 9% Chrome 1% Moly in 3/32" through 3/16" diameter. Only Croloy Electrodes are identified with the Croloy imprint on each Electrode and are manufactured under U.S. patent license.

Champion also offers a full line of Stainless Steel Electrodes in all analyses with either lime or AC-DC coatings. **Champion** is the leading manufacturer of the increasingly popular 16-8-2 composition, which gives unparalleled freedom from cracking in type 347 and 316 weldments.

For further information on any of these electrodes, write today.

THE **CHAMPION** RIVET CO.

Cleveland 5, Ohio — East Chicago, Ind.

For more information, turn to Reader Service card, circle No. 551

PRICES AND SUPPLY

TITANIUM

Sponge (99.3+%)	1.85-2.05
Bars, Rod	6.15-6.40
Plate	8.00-10.75
Sheet, Strip	9.50-11.10
Wire	7.50-8.00

ZINC

Prine Western	.10
Die Casting Alloys[a]	.13
Sheet	.24
Ribbon	.21
Plates	.19

[a]Alloys 2, 3, 5.

METAL POWDERS

Aluminum [a,b]	.40
Brass [a]	.30-.45
Copper (elec or red.)[a]	.40
Molybdenum (98%)	3.80-4.10
Nickel	1.05
Tantalum	49
Tungsten (C-red. 98.8%; H_2-red. 99+%)	3-4[c]
Zirconium	
Flash Grade	11.50
Electronics Grade	15

[a]Price for —100 mesh. [b]Freight allowed. [c]Delivered price.

OTHER NONFERROUS METALS

Cadmium (bars)	1.55
Columbium	55-85
Gold	$35/troy oz
Indium (99.97+%)	$2.25/troy oz
Manganese (99.9%)	.34[a]
Palladium	$19-21/troy oz
Platinum	$72-75/troy oz
Silver	89-91¢/troy oz
Tantalum (sheet, rod)	55-60
Vanadium	80
Zirconium (sheet, strip, bar)	25-35

[a]Delivered price.

IRONS AND STEELS

Mill base prices for large quantities

SEMIFINISHED STEEL ($/net ton)

Ingots, Alloy	77
Billets, Blooms, Slabs	
Carbon, Re-Rolling	77.50
Carbon, Forging	96
Alloy, Forging	114
Seamless Tube Rounds	117.50
Wire Rods	$6.15/cwt

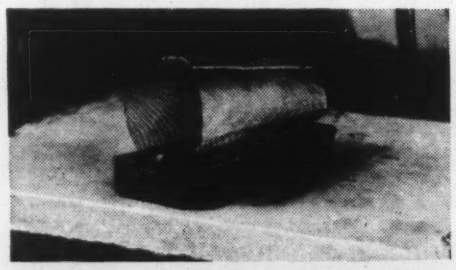
(continued on p 202)

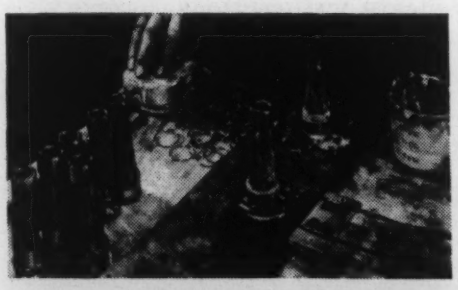
A Brazing Story in Five Parts ...with Handy & Harman EASY-FLO

The Perlman Heat Treating Corp., Westbury, Long Island, brazes aircraft fuel system parts for WEBA, Inc. One of these is a fuel filter screen. It consists of five parts: two stiffeners, a screen and two end fittings, all of 302 stainless steel. All of these parts are joined by EASY-FLO silver brazing, using both induction and hand-torch heating methods.

A novel feature is the induction heating method used to braze the two stiffeners to the screen. It is sort of an "upside-down" method, through an asbestos board and carbon block, on which the screen rests with the EASY-FLO wire preform preplaced. The board and block permit enough passage of heat to melt the alloy to the mesh and stiffeners without excess overflow. Because the alloy won't wet the carbon block, the result is a clean, finished fillet.

The larger, cage-type fitting is HANDY-FLUXED, as is the circular preform of EASY-FLO, then assembled and placed in an induction coil. The smaller end fitting is inserted in the screen, preheated by induction and then torch-brazed, with the alloy being hand-fed. Alloy cost for the entire assembly is ten cents.





The main point here is the adaptability not only of the alloy, but the *brazing method.* Hardly anything stands in the way of brazing that a little ingenuity can't solve, as Perlman Heat Treating has demonstrated. We'll be very glad to bring the full and very beneficial brazing story to your attention. More and more, people with all kinds of metal-joining problems are finding that Handy & Harman silver alloy brazing has most of the answers. Answers that may benefit you.

FIRST, BULLETIN 20 – This informative booklet will get you off to a good start on the values, techniques and economies of low-temperature silver brazing. A copy awaits your request.

Your NO. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

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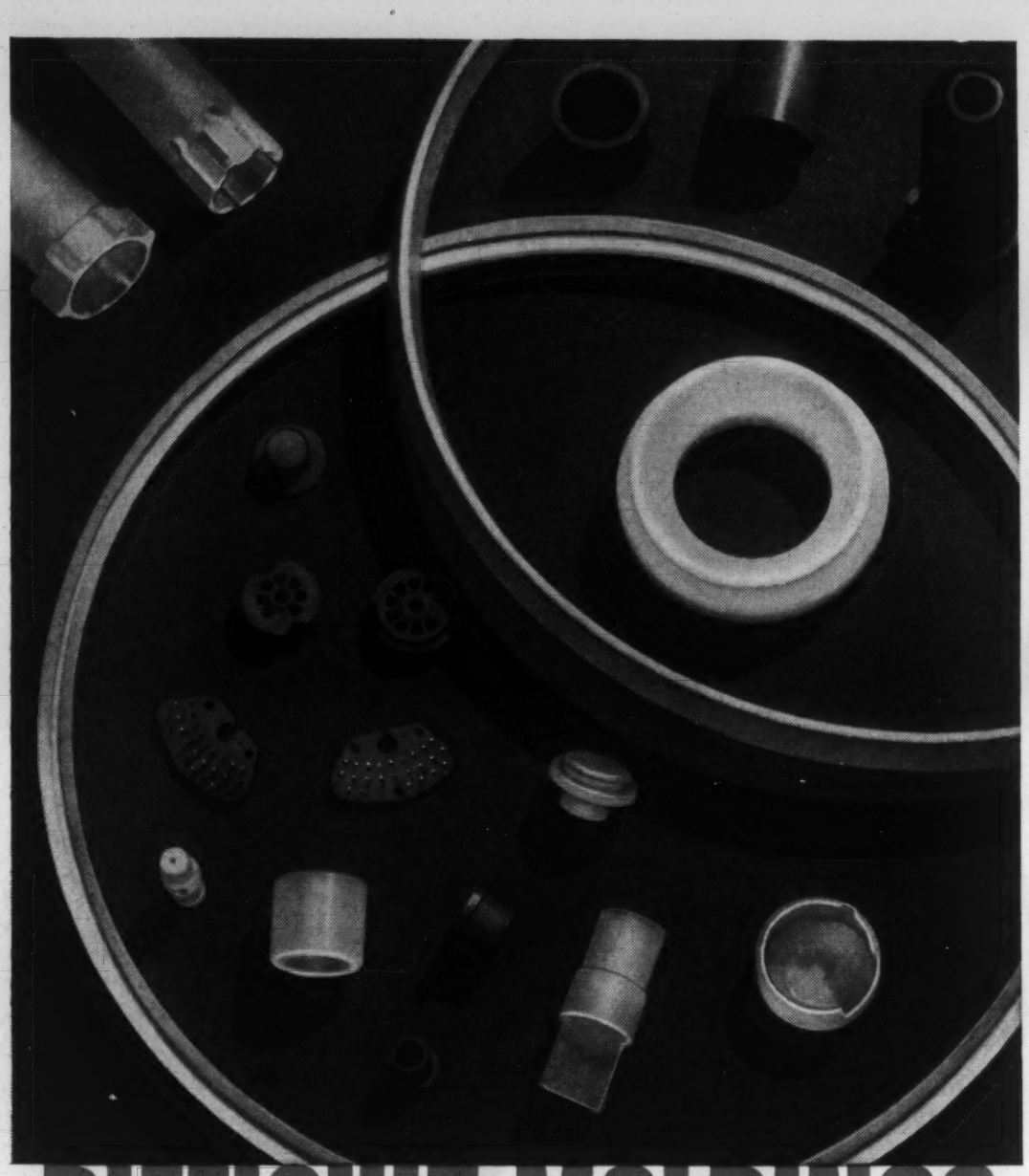


DIFFICULT MOLDINGS from TEFLON, KEL-F

United States Gasket specializes in difficult moldings involving precision tolerances, intricate shapes, delicate wall sections, inserts, molding around metallic structures, inside and outside threaded parts, etc.

They are equipped with unusual "know-how" gained as pioneers and leaders in fluorocarbon plastics fabrication, and the most modern specialized facilities and techniques for cold molding and sintering of TEFLON* T.F.E., as well as the injection molding of KEL-F† and the new thermoplastic TEFLON F.E.P.

Send us your difficult fluorocarbon molding problems for quotations. And call upon us, too, for your requirements of fluorocarbon and nylon sheets, discs, tape, rods, tubing, bars, cylinders, etc., from the world's largest and most complete stocks.

*du Pont Trademark
†M.M.&M. Trademark

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket — Plastics Division of GARLOCK

For more information, turn to Reader Service card, circle No. 479

PRICES AND SUPPLY

FINISHED STEEL ($/cwt)

Form	Carbon	High Str Low Alloy	Alloy
Plate	5.10	7.62	7.20
Sheet, H.R.	4.92	7.27	—
Sheet, C.R.	6.05	8.97	—
Strip, H.R.	4.92	7.32	8.10
Strip, C.R.	7.15	10.65	—
Bar, H.R.	5.42	7.92	6.47
Bar, C.F.	7.30	—	8.77

STAINLESS STEELS ($/lb)

Material	Forging Billets	H. R. Bars	Plate	Sheet, Strip
Austenitic				
301, 302, 302B, 303, 304, 305	.38-.41	.44-.48	.46-.51	.51-.59
321[a]	.47	.56	.60	.66
347[a]	.56	.65	.70	.80
Martensitic				
410[a]	.28	.34	.35	.40
416	.29	.34	.36	.48
403	.32	.38	.40	.48
420, 440	.34	.41	.45	.62
Ferritic				
405, 430, 430F[a]	.30	.34-.35	.36-.38	.41-.47
442	.32	.38	.40	.56
431	.38	.44	.46	.54
446	.39	.47	.48	.70
High Mn				
202[a]	.37	.43	.45	.49
Extra Low C				
304L	.48	.56	.59	.63
316L	.70	.81	.85	.89
Precip Hard.				
17-7PH	.66	.73	.85	.90
PH 15-7 Mo	.86	.93	1.11	1.16

[a]Ingot price approx 60% of billet price.

METAL POWDERS ($/lb)[a]

Sponge Iron	.10-.11
Electrolytic Iron	
Annealed (99.5%)	.37
Unannealed (99+%)	.36
Stainless Steel	
304	1.07
316	1.26

[a]Price for —100 mesh.

IRON ($/gross ton)

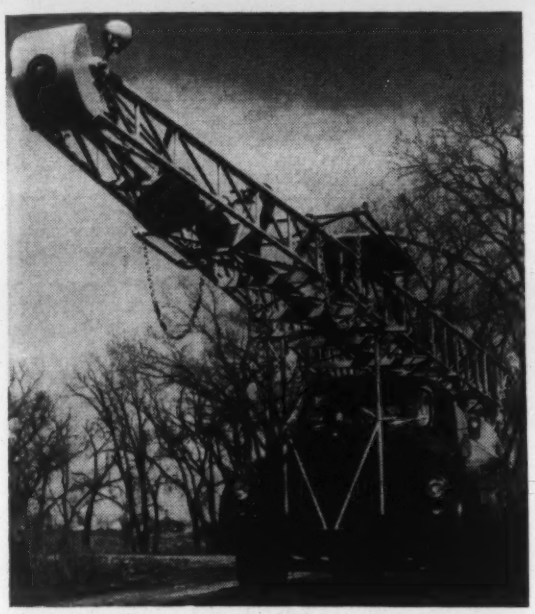
Pig	65-66

(continued on p 204)

For more information, circle No. 464

How (USS) Shelby Seamless Tubing improves the design of this portable drilling rig

This is the FAILING 1500 HOLEMASTER®, an all-purpose drilling unit built by the George E. Failing Co. of Enid, Oklahoma. Truck-mounted, the rig will handle drill pipe and casing loads up to 25,000 lbs. It is rated to drill to 1,500 feet with 2⅜-inch drill pipe.

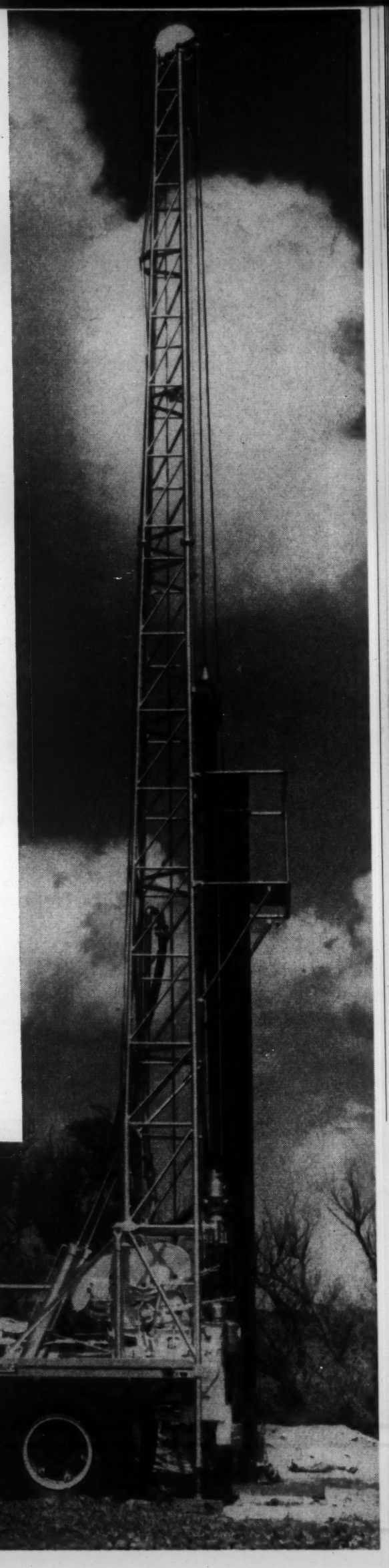


Shelby* Seamless alloy steel tubing was used extensively in the 42-foot mast. It was chosen as the design material because it offers the ultimate in strength and rigidity in proportion to its size and weight. It is uniform throughout, dimensionally accurate, and possesses superior welding and machining properties. Furthermore, the symmetrical tubing improves the general appearance of the rig. For the four vertical legs, which bear the brunt of the weight, Shelby Seamless was used as follows:

162 ft. of 2⅜" OD x 5/32" wall
18 ft. of 1⅝" OD x 11 ga. wall
66 ft. of 1⅜" OD x 11 ga. wall
185 ft. of 1" OD x 11 ga. wall

USS* Shelby Seamless Mechanical Tubing is available in a wide range of diameters, wall thicknesses, various shapes and steel analyses. For further information or immediate delivery of Shelby Tubing, call your Shelby Seamless Tubing Distributor. Or, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

"Shelby Tubing is made by the world's largest and most experienced producer of tubular products—NATIONAL TUBE"



National Tube
Division of (USS) United States Steel
*TRADEMARK

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division • United States Steel Export Company, New York

CEC Transfer Line installation shows temperature of outside pipe only 2°F. different from ambient.

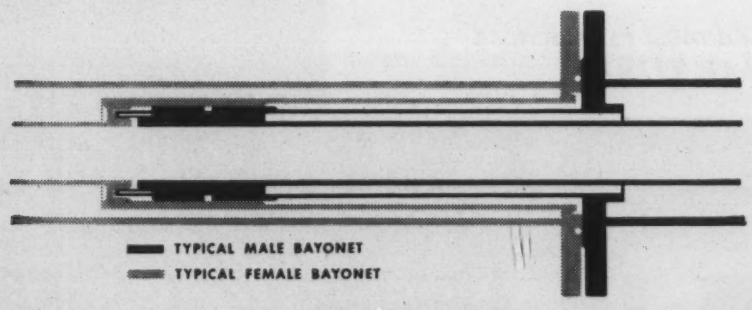
Pipe carries liquid O_2 continuously...why no frost?

This is a pipe within a pipe... with a vacuum in between. Like a Thermos bottle.

Heat transfer from pipe to pipe is only 3 BTU/ft./hr.

Compare this with 186 BTU/ft./hr. for pipe insulated with fiberglass, foamglass, cork, etc.—with 290 for asbestos-insulated pipe—with 340 for pipe insulated with ⅛" frost—and with 600 and above for noninsulated pipe, and you see why CEC vacuum-jacketed transfer lines are ideal for moving liquid rocket and missile fuels.

And the *entire* system is vacuum-tight. Heat transfer is very low even at the joints and flanges, again shown by the absence of frost.



This special bayonet joint, developed by CEC, gives complete and permanent sealing between sections of transfer line. Notice the O-ring groove in the male bayonet and the capturing flange in the female side. The O-ring can never leave the flange. Flanges are machined to a 63 micro-inch finish.

A complete CEC transfer system includes the transfer lines, available in lengths up to 40 feet in various diameters to meet customer specifications; vacuum pumps; gauges; vacuum-jacketed valves; baffles; traps; and leak detectors.

For complete information contact the nearest CEC sales office. Complete engineering assistance in the field is available.

For preliminary details, write for Bulletin 4-80.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N.Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

For more information, turn to Reader Service card, circle No. 563

PRICES AND SUPPLY

CLAD STEELS (¢/lb)[a]

Cladding Metal	10%	15%	20%
Stainless			
304	38	42	47
304L	41	45	50
316L	49	55	60
321	40	45	49
347	42	48	53
430	30	33	37
Inconel	60	70	81
Nickel	52	62	73
Monel	54	64	74

[a]Prices given for three cladding thicknesses.

TIN PLATE ($/base box)

Hot Dip (1.25-1.50 lb)	10.05-10.30
Electrolytic (0.25-0.75 lb)	8.75- 9.40

FINISHES AND COATINGS

ORGANIC COATINGS

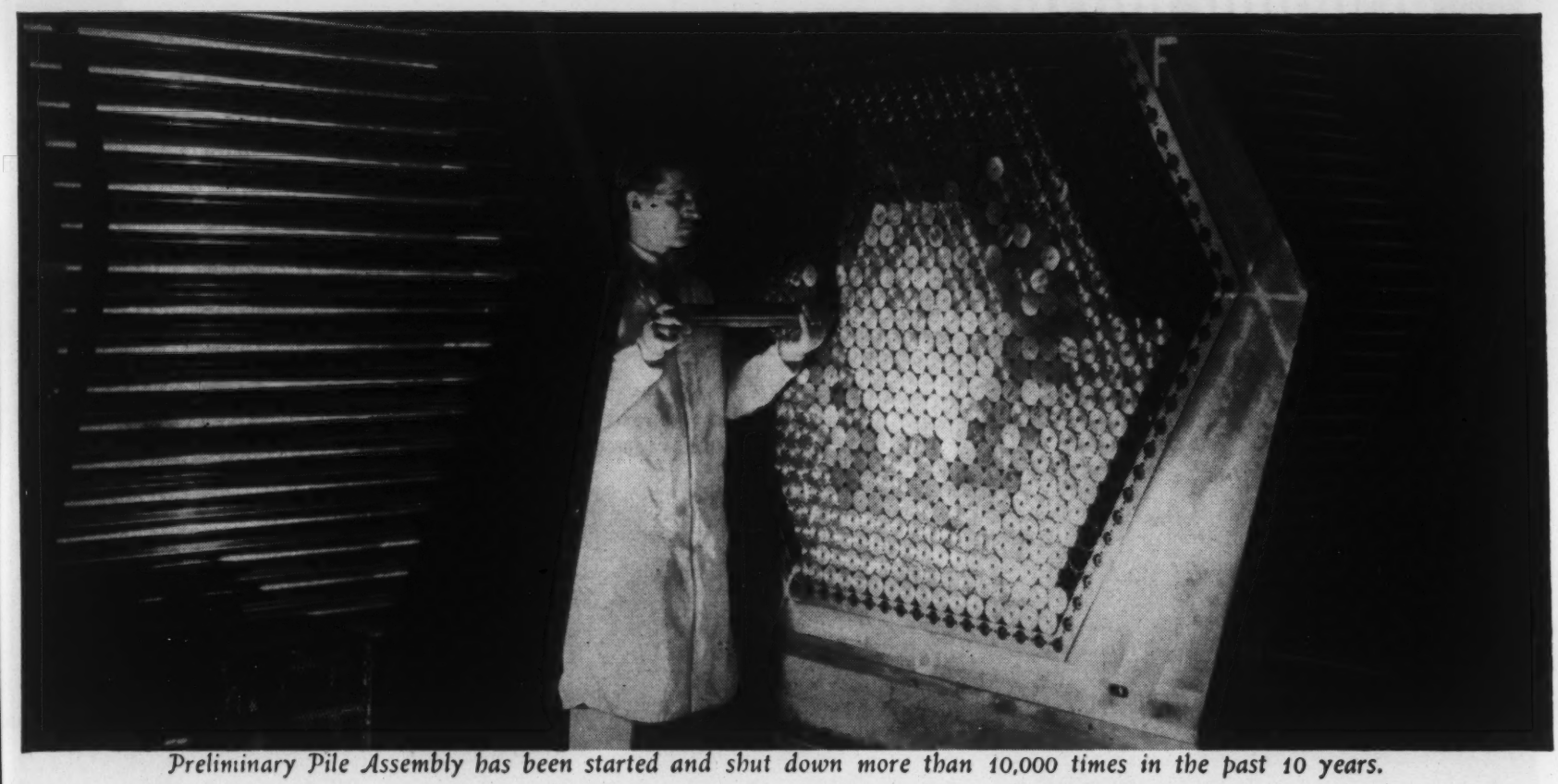
Material	Avg Thk per Coat, mil	Mils Required[a]	Cost, ¢/sq ft/dry mil[b]
VARNISHES, ENAMELS			
Short Oil Phenolic			
Varnish	1.0	1.0	1.5
Enamel	1.2	1.0	1.75
100% Phenolic	1.0	1.5	1.75
Straight Oil-Modified			
Alkyd	1.5	1.5	1.5
Alkyd-Amine (90-10)	1.5	1.5	1.75
Alkyd-Phenolic (50-50)	1.5	1.5	1.75
Alkyd-Vinyl (50-50)	1.0	2.0	2.0
Alkyd-Styrene (70-30)	1.2	1.5	1.75
Epoxy	1.8	1.8	2.0
Silicone	.5-1.0	.5-1.0	6.0
Furane	2.0	2.0	1.0
Neoprene	5.0	5.0	1.5
DISPERSION COATINGS			
Phenolic	1.0	1.5	1.75
Vinyl	1.0	2.0	2.5
Fluorocarbon	1.0	1.0	15.0
LACQUERS			
Nitrocellulose	1.0	2.0	2.5
Vinyl	1.0	2.0	2.5
Acrylic	1.0	2.0	2.75
Butyrate	1.0	2.0	2.75

[a]Thickness over phosphate coating required for exterior durability on steel. For purely decorative coating. 1 mil will usually suffice.
[b]Materials cost only. Realistic price comparison can be made only on basis of dry applied coating, not on basis of cost per gallon.

furthering
creative technology at

The KNOLLS ATOMIC POWER LABORATORY

To men concerned with pushing back the frontiers of reactor technology, the many facilities for fundamental and applied research at KAPL hold a special interest. Among the unique critical assemblies for experimental purposes is the PPA, *pictured below*. This Preliminary Pile Assembly can be shut down and restarted in 15 minutes in order to rearrange fuel elements to simulate different reactor designs. Only last year two new buildings were completed to house two additional experimental reactors, a 704 computer, and to provide modern office facilities for an enlarged mathematical staff.



Preliminary Pile Assembly has been started and shut down more than 10,000 times in the past 10 years.

NEW SCIENTIFIC AND ENGINEERING POSITIONS ARE NOW OPEN IN ADVANCED NUCLEAR DEVELOPMENT AND DESIGN OF NAVAL PROPULSION SYSTEMS

If you want the stimulation of working toward the solution of increasingly complex nuclear power plant problems in a laboratory atmosphere, The Knolls Atomic Power Laboratory welcomes your inquiries. Current openings are listed below. Degree required; advanced degree and/or related experience preferred.

CHEMICAL ANALYSIS, REACTOR MATERIALS & PROCESSES
DYNAMIC FLOW CORROSION TECHNOLOGY
RADIOCHEMISTRY AND INSTRUMENTATION
REACTOR CORE STRUCTURAL FABRICATION
METALLURGICAL & MANUFACTURING PROCESSES DEVELOPMENT
REACTOR MATERIALS APPLICATION

U. S. CITIZENSHIP REQUIRED.

If you can qualify, send letter giving details in confidence to: Mr. A. J. Scipione, Dept. 39-MR.

Knolls Atomic Power Laboratory
OPERATED FOR A.E.C. BY
GENERAL ELECTRIC
SCHENECTADY, NEW YORK

For more information, turn to Reader Service card, circle No. 512

How Glidden can help you produce better Metal Powder Parts...

Whether you are interested in improving the operation of an existing metal powder parts department, or desire to establish a new parts department, Glidden can help you.

Glidden not only offers the helpful assistance of its metal powders lab and trained metallurgists, but can also supply you with RESISTOX Metal Powders that permit faster production of precision parts with greatly improved finish, appearance and performance characteristics. And Glidden has the facilities to produce up to 30,000 pounds of RESISTOX Metal Powders in one batch—an important factor in complete uniformity of mass-produced parts.

Why not take a careful look at the manufacturing method you are now using. Make certain you are not overlooking the economies, speedier fabrication and superior parts performance you can get by using Glidden RESISTOX Metal Powders. Write on your letterhead for complete details.

THE GLIDDEN COMPANY

Chemicals—Pigments—Metals Division

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QUALITY Glidden PRODUCTS

CHEMICALS PIGMENTS METALS

COPPER POWDER • LEAD POWDER • TIN POWDER CUBOND COPPER BRAZING PASTE • BRASS POWDER • ALLOY POWDER • CUPRIC OXIDE • CUPROUS OXIDE • COPPER PIGMENT • CUPROUS SULPHIDE • FILTER POWDER

For more information, turn to Reader Service card, circle No. 486

News OF INDUSTRY

Design Show, Conference Attended by 18,000

Approximately 18,000 engineers, designers and executives visited over 400 exhibits at the third annual Design Engineering Show held at Chicago's International Amphitheatre late in April.

Exhibits at the show, which was sponsored by Clapp & Poliak, Inc., included an inestimable number of materials, finishes, parts and components that go into the making of end products. Many booths featured actual demonstrations of the use of materials in product design.

The Design Engineering Conference, sponsored by the Machine Design Div. of the American Society of Mechanical Engineers and held in conjunction with the Design Show, covered the materials, mechanical, and power and control aspects of design engineering.

In general, both the Show and Conference appeared to be extremely successful in terms of number of people attending and information available.

"I can't understand it. He says our stuff doesn't last any time at all."

1958 ASTM Meeting To Be Held in Boston

The 61st annual meeting of the American Society for Testing Materials will be held June 22-27 at the Hotels Statler and Sheraton-Plaza, Boston. According to the Society, this year's meeting will be the largest ever held.

A total of 42 technical sessions and symposiums and more than 800 committee meetings are scheduled. Among the many topics to be covered are: fatigue, effects of radiation on materials, high temperature properties of materials, durability of structures, crack propagation, and materials research. In all, more than 200 papers will be presented.

For further information, contact Val Laughner Associates, 755 Boylston St., Boston 16, Mass.

New Laboratory for Metal Powder Research

A new metal powder laboratory that enables pilot-scale experimental work to be carried out under conditions identical with normal full-scale operations, has been built by F. J. Stokes Corp.

In addition to having a complete range of standard produc-

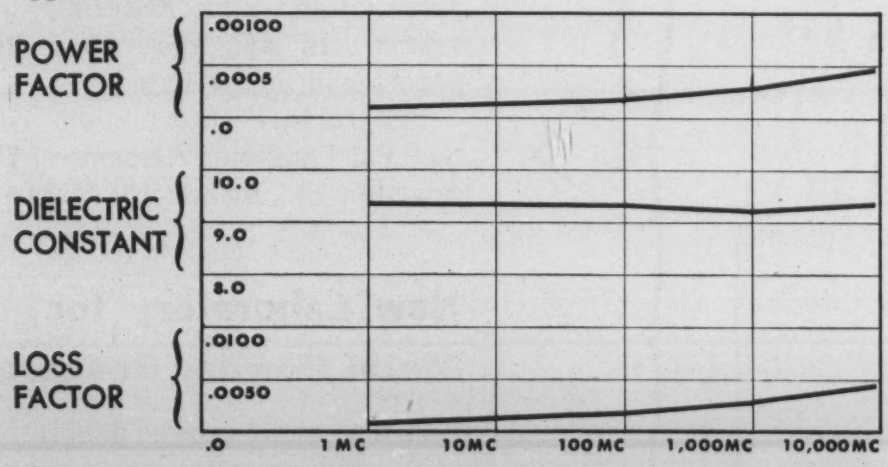
Long Kiln–Short Delivery

for Centralab® High Alumina Ceramics

Fast delivery of 95% and 85% High Alumina, to your most critical specifications, is assured by Centralab's new 80 foot continuous kiln. First of its design in the United States, this new kiln is capable of producing 21 tons of exceptional quality High Alumina every month. Consistent reproduction of electrical and physical properties from batch to batch is guaranteed.

Superior Electrical Properties at High Frequencies

Extremely stable dielectric constant and a power factor of .00045 at 9000 megacycles (see graphs of Bureau of Standards tests below) make Centralab Body 206 (95% alumina) your logical choice for all types of high reliability electrical and electronic applications.



For complete specifications and design data write Centralab or consult Sweet's Product Design File (folio 4 a/ce).

Centralab®
X-5830

A DIVISION OF GLOBE-UNION, INC.
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VARIABLE RESISTORS • SWITCHES • PACKAGED ELECTRONIC CIRCUITS
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

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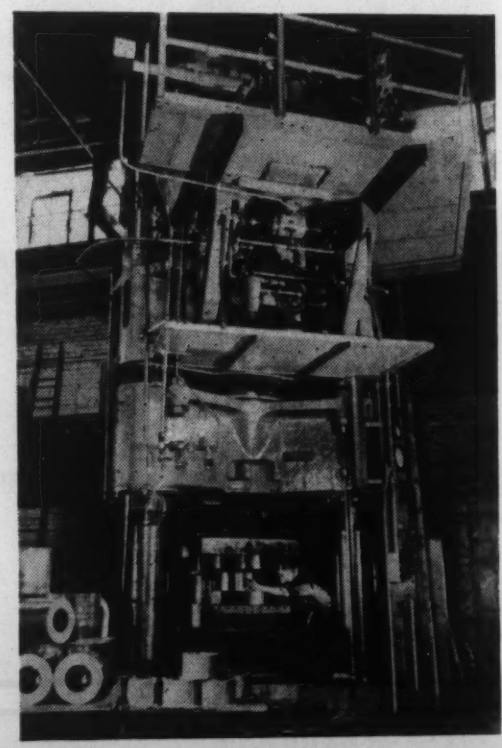
News OF INDUSTRY

tion-type equipment, the new laboratory is equipped to test metallurgical properties of finished metal powder parts.

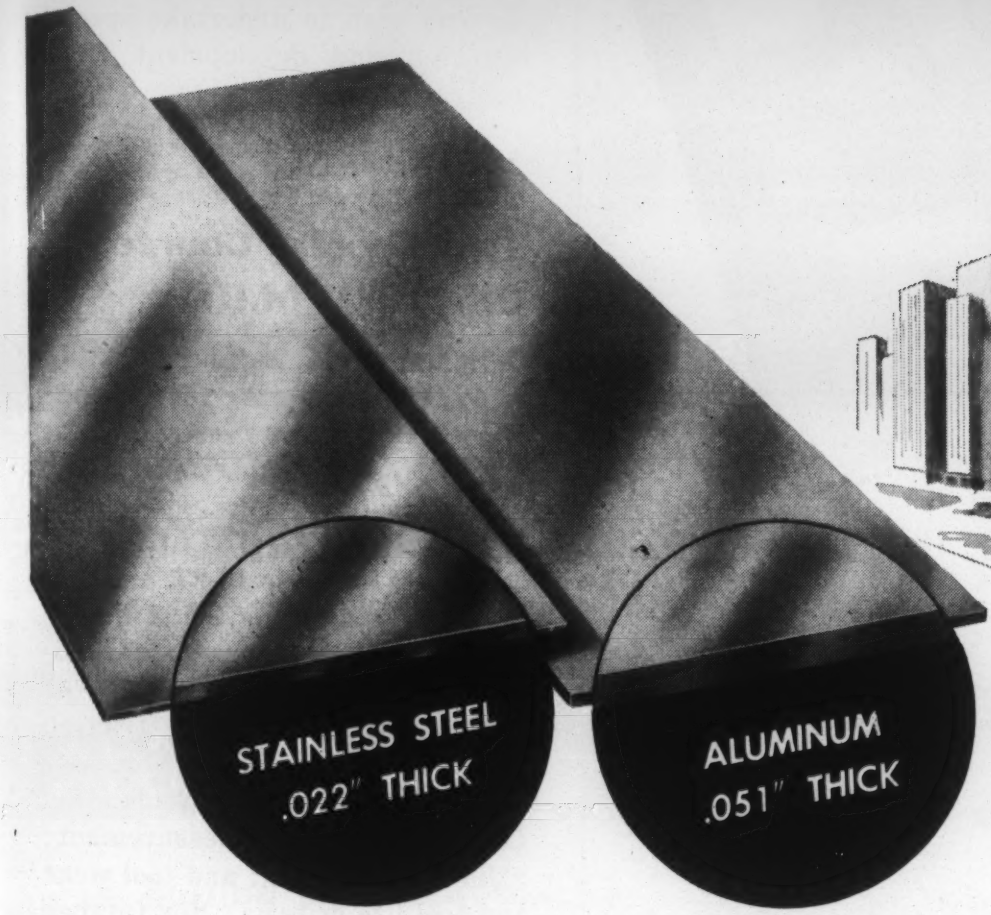
Primary purpose of the new laboratory is to perform research aimed at the development of new processing techniques. Some specific objectives include: the development of techniques for pressing mixtures of otherwise uncombinable metals; testing various compositions of metal powders; evaluating the applicability of powder metal processing to parts now being made by other methods; and increasing production rates, or reducing production costs, of specific metal powder parts.

According to Stokes, the new laboratory's facilities will be made available at nominal cost to outside firms who may wish to evaluate the application of their products to powder metal processing

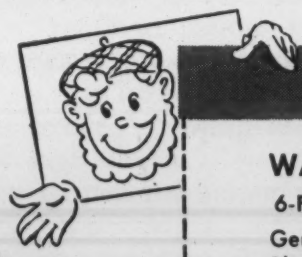


Largest metal powder press—Shown above is what is claimed to be the world's largest metal powder press. According to Amplex Div., Chrysler Corp., it is capable of exerting a force of 6,000,000 psi and producing parts up to 30 in. in dia.

STAINLESS COSTS LESS THAN ALUMINUM—



Do you know that the square-foot cost of stainless steel sheet for curtain wall panels is usually equal to or lower than aluminum when compared in thicknesses of equal indentation resistance? For example, Type 302 stainless steel, .022″ thick is equal to .051″ aluminum and costs only 62¢ per sq. ft., as compared to 67¢ per sq. ft. for 3003-H14 anodized aluminum.



For additional information on all gauges, fill in and mail the coupon.

Washington Steel Corporation
WASHINGTON, PENNSYLVANIA

MAIL COUPON *Today!*

WASHINGTON STEEL CORPORATION
6-F Woodland Avenue, Washington, Pa.

Gentlemen:
Please send me full information on comparative costs of stainless steel vs. aluminum for curtain wall panels.

Name_____
Position_____
Company_____
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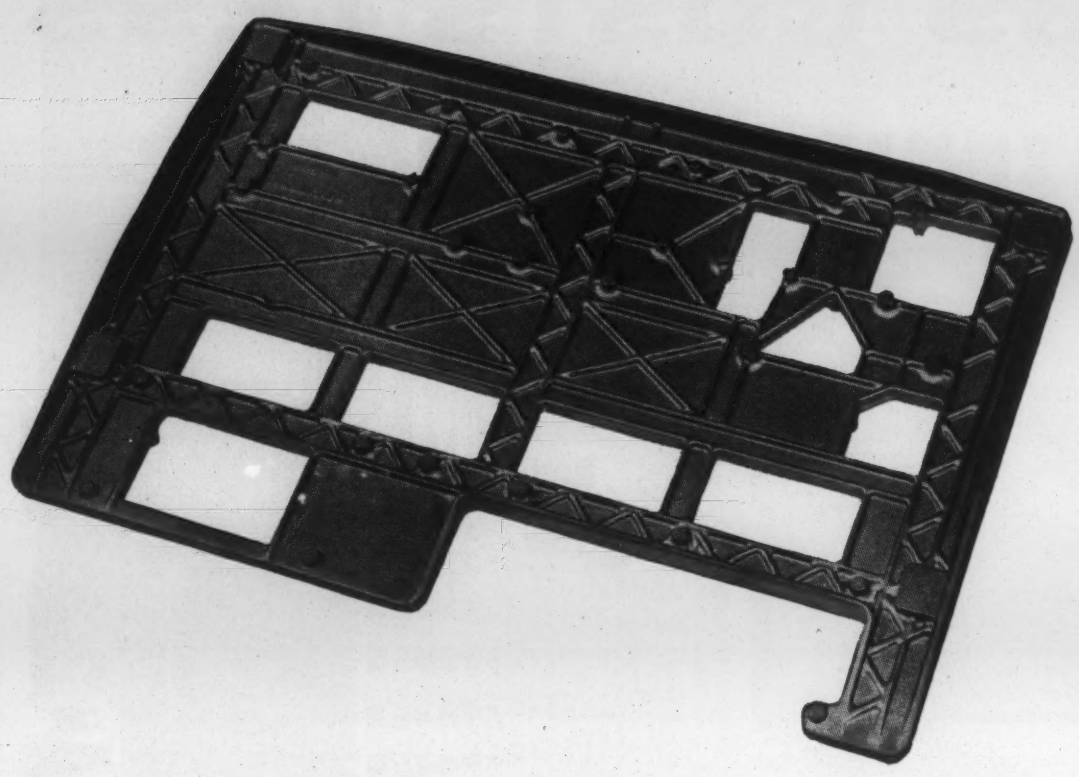
City_____ Zone____ State_____

For more information, turn to Reader Service card, circle No. 529



EXCELLENT BASE FOR PROFITS

This ninety-six pound casting was made for the National Cash Register Co. of Nodulite®, Hamilton Foundry's ductile iron. The casting forms the base for the new Post-Tronic Accounting Machine. It measures 37½" by 23½" with sections varying from ¼" to 1½". Ductile iron was chosen for this part because of its ductility, dimensional stability, rigidity, and machinability.

Sharp pencil buyers know that the *ultimate* cost of a casting rather than the purchase price is most important to the cost of the end product. Dimensional accuracy, uniform machinability, fine surface finish, low rejects and delivery of orders on schedule result in castings at lowest ultimate cost and insure your reputation for product quality.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules —will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY

The Hamilton Foundry & Machine Co., 1551 Lincoln Ave., Hamilton, Ohio • TW 5-7491

For more information, turn to Reader Service card, circle No. 513

or who wish to undertake special research and development on a contract basis.

Two Special Courses Offered at M.I.T.

"Metal Cutting" and "Casting of Light Metals" are the titles of two special summer courses to be offered by Massachusetts Institute of Technology.

The first, Metal Cutting, is scheduled for June 17-27, and will cover such things as the structure and properties of metals; mechanics of cutting; plastic flow of metals during cutting; friction and wear in cutting processes and the role of cutting fluids; surface finish and its measurement; grinding of metals; and tool wear and tool life criteria. For further information, write to Prof. Milton C. Shaw, Metals Processing Div., Mechanical Engineering Dept., Massachusetts Institute of Technology, Cambridge 39, Mass.

The second course, Casting of Light Metals, will be held June 17-21 and will cover: basic engineering and metallurgical factors affecting the quality of light metal casting; commercially practical foundry techniques; design and applications; and research developments. For further information, write to Prof. Howard F. Taylor.

Plastics End Products Compete for $1000

The latest effort to ". . . stimulate and encourage the imaginative use of plastics materials . . ." in the development and improvement of end products is being made by Chicago Molded Products Corp. in the form of the "Bachner Award."

According to the company, $1000 and an inscribed plaque

These OTTAWA 60 DIES PAYOFF BIG IN 3 WAYS

- ★ Buffing Time Reduced ½
- ★ Rejects Reduced 20%
- ★ Stoning and Regrinding of Dies Reduced 75%

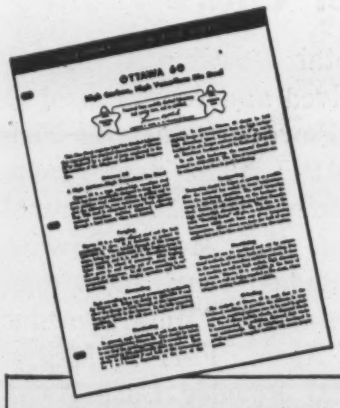
One way to increase profits is to reduce finishing costs. That's what a fabricator of hearing aid cases accomplished when he switched from regular die steel to A-L's air hardening Ottawa 60 high carbon-high vanadium grade.

Ottawa 60 dies produced stainless steel cases which were free from galling and scoring—were nearly perfect as they came out of the dies. Less than half the previous buffing time was needed to bring them to the required high finish. Rejects—which ran about 20 percent before the use of Ottawa 60—were reduced almost to the point of elimination. Also, the new Ottawa 60 dies required stoning and regrinding only a quarter as often as the standard tool steel dies they replaced.

This same manufacturer has passed along significant savings to other customers through the use of Ottawa 60. By practically eliminating rejects due to corner cracking and scoring, customers receive better stamped parts at lower per-piece cost.

Let us show how you, too, can save with A-L tool steels and, at the same time, furnish your customers a better product.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.



Write for BLUE SHEET on OTTAWA 60

This concise four-page folder gives all needed handling and shop treatment details on Ottawa 60. Included is certified laboratory information on physical characteristics, and complete data on forging, annealing, hardening, tempering, etc. *Ask for your copy.*

ADDRESS DEPT. MM-6

WSW 6648

For nearest representative, consult Yellow Section of your telephone book.

For complete MODERN Tooling, call

Allegheny Ludlum

AL® FINE TOOL STEELS SINCE 1854

For more information, turn to Reader Service card, circle No. 491

design for high energy and magnetic permanence with Stackpole *Cera*MAGNET® ceramic magnets

CERAMAGNET® PERMANENT MAGNETS give the designer truly *permanent* magnetic energy that's low in cost and in a shape best suited to the function . . .

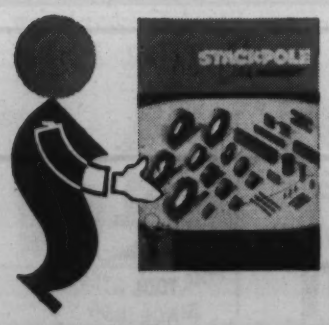
in mechanical/holding applications as latches, seals, couplings

in electrical/mechanical applications as magnetic drives, rotors, relays

in electronic/polarizing applications as magnetic focussing devices, ion traps

in other applications as arc snuffers, temperature-sensitive devices

Stackpole Ceramagnet ceramic permanent magnets produce exceptionally high coercive force. Their magnetism is permanently retained even in the presence of strong opposing fields, or when used without keepers or other short-circuit conditions. Other advantages include electrical resistivity approaching infinity, negligible eddy current losses, use of non-critical materials, ability to be molded into any shape or size.



Since the design and economic advantages of using Ceramagnet permanent magnets vary with the application, you'll want to make a thorough evaluation of this new magnetic material. For facts and figures, write for Bulletin RC-11A or call your local Stackpole Field Service Engineer.

STACKPOLE

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

For more information, turn to Reader Service card, circle No. 447

News OF INDUSTRY

will be awarded for ". . . outstanding contribution to the practical application of molded and formed plastics products." Entries will be evaluated against the following qualifications:

1. A manufactured item, which, through unique application of plastics, promises to have a meritorious effect on the industry that has adopted the application and, to some extent, on industry as a whole.

2. A practical production item exhibiting an imaginative blend of materials, production techniques and design.

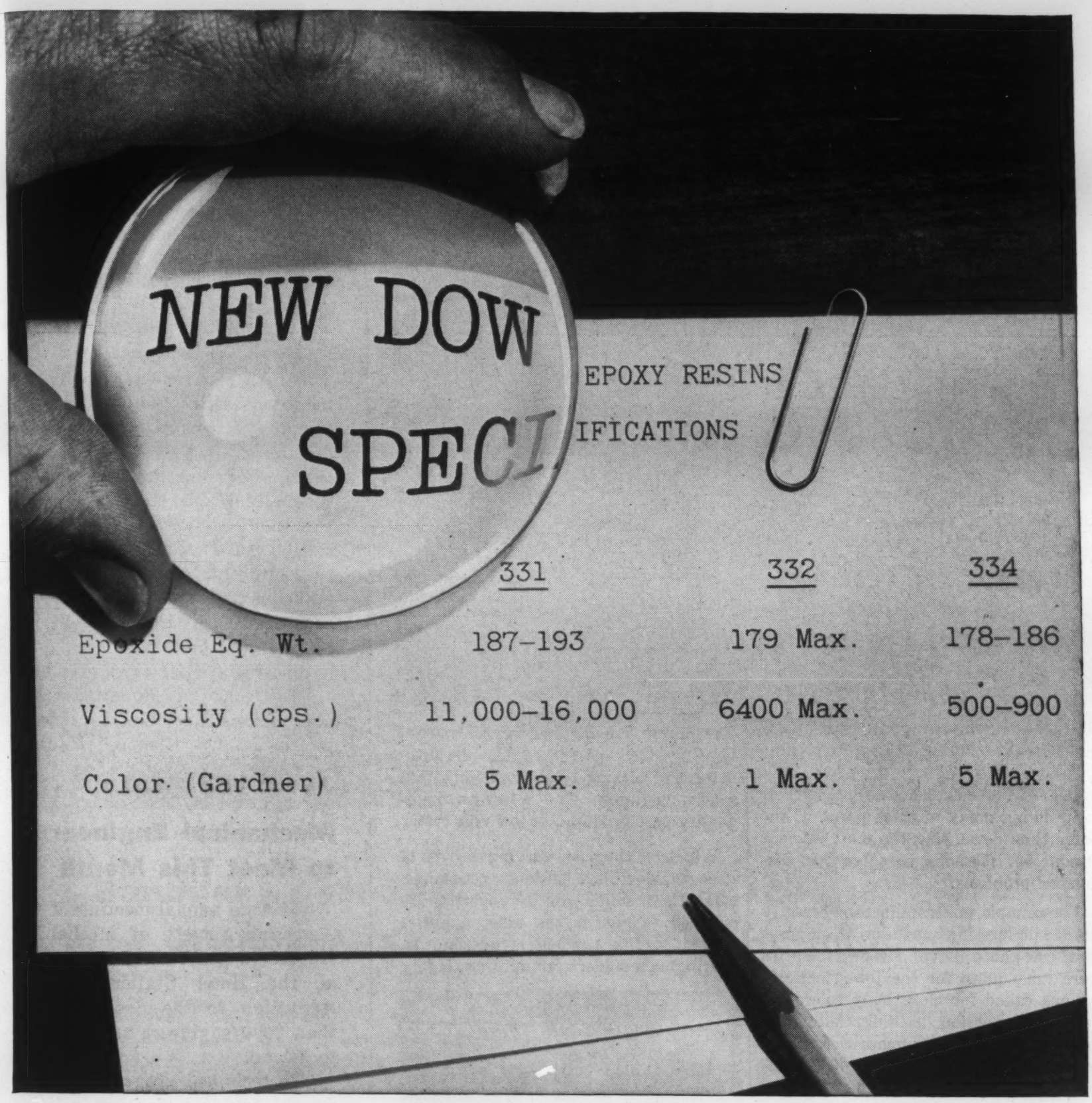
3. Originality of achievement.

All parts must be recent productions items, commercially offered for sale not prior to Jan 1 1957. The contest closes Aug 15, 1958. For application blanks and further information, write to William T. Cruse, Secretary, Bachner Award Committee, c/o Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y.

Metal Powder Group to Cover Entire Field

The Metal Powder Assn. has been dissolved and reorganized as the Metal Powder Industries Federation (MPI). The new group, formed during the 14th annual meeting of the Metal Powder Assn., includes four individual trade associations: Metal Powder Producers Assn., Ferrite Mfgrs. Assn., Metal Powder Core Assn. and Powder Metallurgy Equipment Mfgrs. Assn. In addition, a

USE THE 'SELECTOR'—You will find properties of most engineering materials, plus names and addresses of suppliers, in M/DE's *Materials Selector* reference issue, published last September.



	331	332	334
Epoxide Eq. Wt.	187–193	179 Max.	178–186
Viscosity (cps.)	11,000–16,000	6400 Max.	500–900
Color (Gardner)	5 Max.	1 Max.	5 Max.

New Dow epoxies feature "lens clear" liquid resin

Dramatic evidence of the striking clarity and purity of Dow Epoxy Resin 332—unique member of Dow's new line of liquid epoxy resins—is shown in the illustration above. The magnifying lens was actually cast from this new water-clear resin. In addition to improved clarity and uniformity, DER 332 has very low viscosity, longer pot life and greater heat resistance than conventional epoxies.

Also available, for formulations where absolute purity is not so important, are Dow Liquid Epoxy Resins 331 and 334.

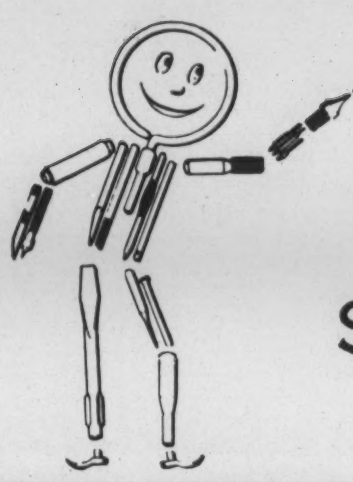
Dow's position as a basic producer of all epoxy raw materials assures top quality control and a narrower range of specifications. It will also enable Dow to introduce, in the near future, a complete line of solid epoxy resins and a new line of polyfunctional liquid epoxy resins outstanding in high temperature service.

Prompt delivery of these three Dow Liquid Epoxy Resins can be made in drums, truck or tank car lots. For more information contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Coatings Sales Dept. 2259L-1.

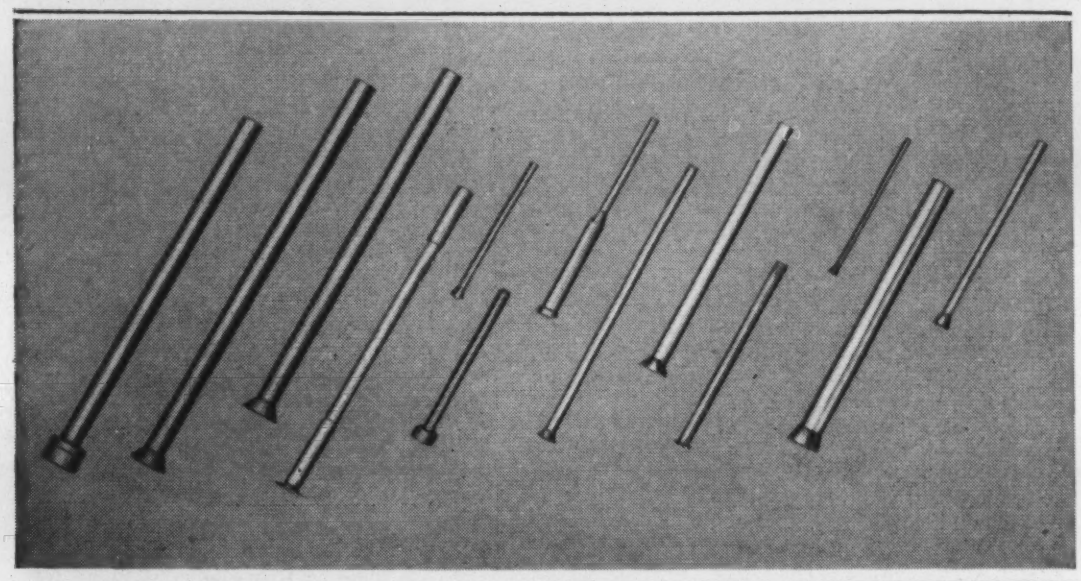
EPOXY

YOU CAN DEPEND ON DOW

For more information, turn to Reader Service card, circle No. 408



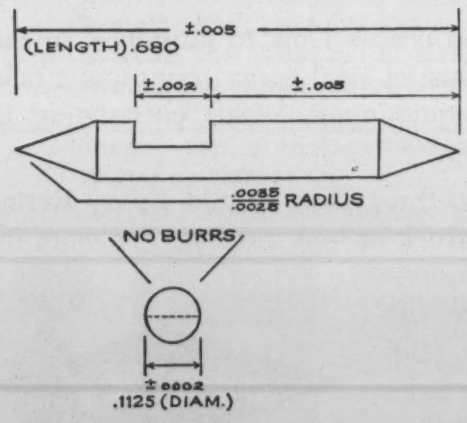
NEWS
from Torrington on
SMALL PRECISION METAL PARTS



Here at Torrington, our "Specialties" machines are constantly at work producing an endless variety of custom-built small precision metal parts. Our engineers help design many of these parts, at the same time developing the most efficient production methods to solve our customers' problems.

For example, one manufacturer recently needed perforating punches with an upset head (see photo above). His own facilities were inadequate for the job . . . specifications called for close body tolerance, grinding, precision heading, hardening and annealing. The punches were to be made from tool steel and produced without flash to allow proper seating. Torrington engineering and production facilities solved his problem.

Another—the volume production of timer parts with low cost a critical factor.



For this job, Torrington developed special high-speed equipment to provide automatic end turning and cross milling in a single operation. The result—a high-quality part produced at low unit cost.

Whatever the part, varying degrees of strength, ductility, hardness, toughness, magnetic or nonmagnetic properties are required to give it the exact qualities needed for its particular function. In Torrington's modern laboratories, highly

experienced metallurgists and engineers are employed to insure that each precision metal part is produced by the most efficient process and to the highest standards required for its application. They'll be glad to help you on all metallurgical problems.

If you have problems involving custom-built small precision metal parts in large quantities, write direct to

The Torrington Company, Specialties Division, 777 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

For more information, turn to Reader Service card, circle No. 544

technology division, created for "technical development," will function through the newly-created American Powder Metallurgy Institute.

According to the new Federation, the change was made because ". . . various groups of manufacturers producing a particular type of product by powder metallurgy techniques needed the benefits of the broad scope of commercial and technical activities that only a large trade association could offer." Each of the trade groups will retain its autonomous position as a separate organization, with its own officers, by-laws and budget.

Officers of MPI are: president —Dr. George A. Roberts, Vanadium-Alloys Steel Co., and executive secretary—Kempton H. Roll.

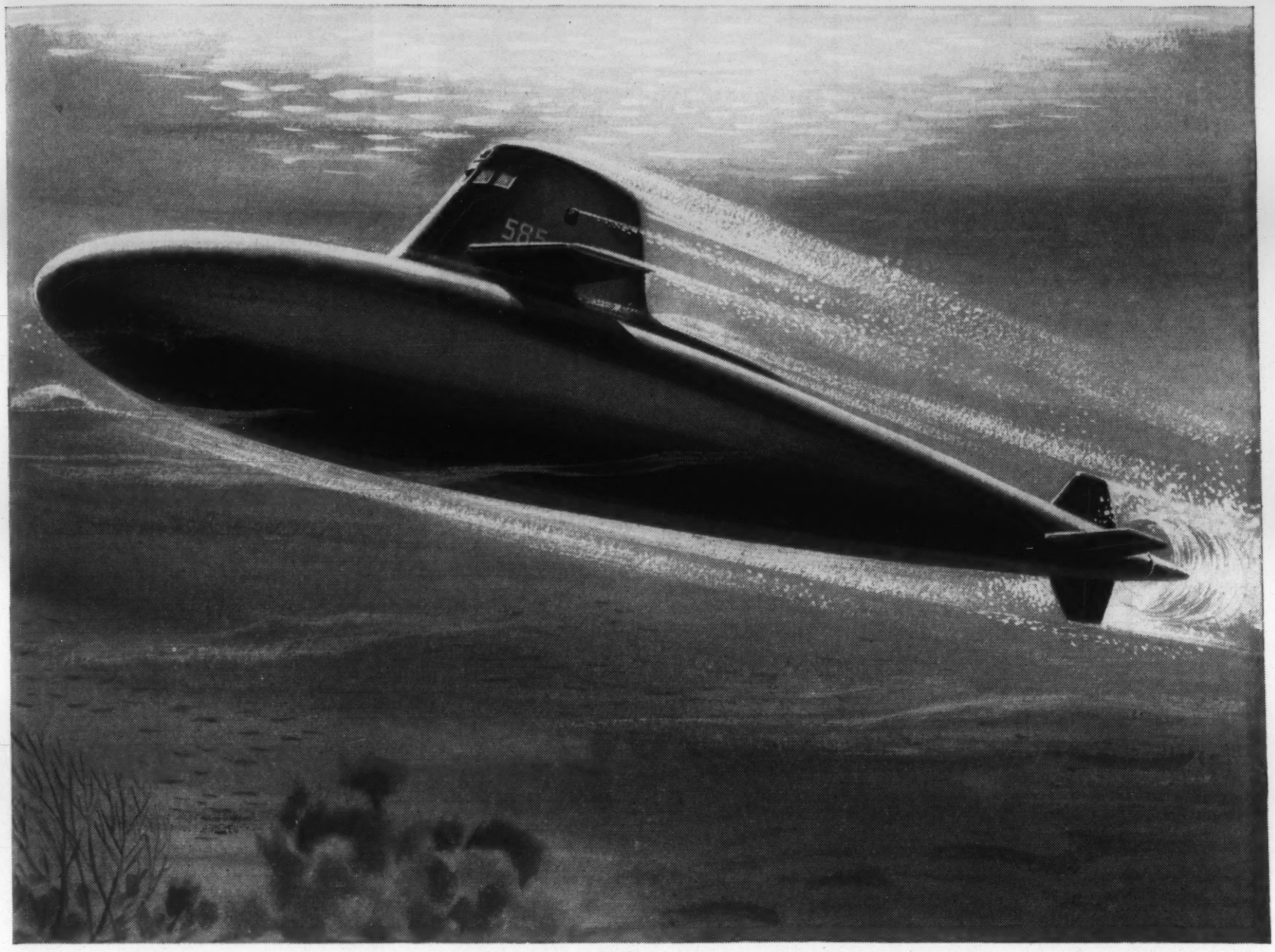
Mechanical Engineers to Meet This Month

The semi-annual meeting of the American Society of Mechanical Engineers will be held June 15-19 at the Hotel Statler, Detroit. According to the Society, more than 2000 engineers are expected to attend.

The technical program planned for the four-day meeting includes sessions on power, safety, design, fuels, rubber and plastics, heat, production and solar energy.

Paint Research Group Set by Federation

The Federation of Paint and Varnish Clubs has established a research organization known as the Paint Research Institute, Inc. Purpose of the Institute will be to 1) engage in basic research by establishing fellowships and projects at educational institutions; 2) interest and direct top-level scientists toward the



Sandusky cylinders help the Skipjack CRUISE, DIVE, STEER, BREATHE and FIGHT!

Centrifugally cast cylinders by Sandusky play vital roles in the U. S. Navy's newest atomic-powered submarine, No. 585 *Skipjack*, as components of the nuclear propulsion system, the steering and diving systems, the torpedo firing mechanism, and radar and induction mast assemblies.

The *Skipjack* is the prototype of a new series of seven submarines all with blimp-shaped hulls for greater underwater speed. Her design and materials specifications were laid down by the U. S. Navy and her builder, The Electric Boat Division of General Dynamics Corporation, who chose Sandusky Centrifugal Castings to do more than ten jobs in structural, mechanical, pneumatic, and hydraulic applications.

All of these components – centrifugally cast of heat and corrosion-resistant stainless steels, high-strength carbon steels, Monels, and bronzes–provided the *Skipjack's* designers with the required mechanical and physical properties at the lowest cost.

You, too, may find a ready solution to your cylindrical problems in Sandusky Centrifugal Castings. We invite your inquiries.

Sandusky cylinders are cast and machined in this range:

From 7″ to 54″ O.D.

Up to 33 ft. in length (depending on diameter)

Light or heavy-walled

In a variety of alloys including Stainless, Carbon, Low Alloy Steels. A full range of Copper-Base, Nickel-Base Alloys.

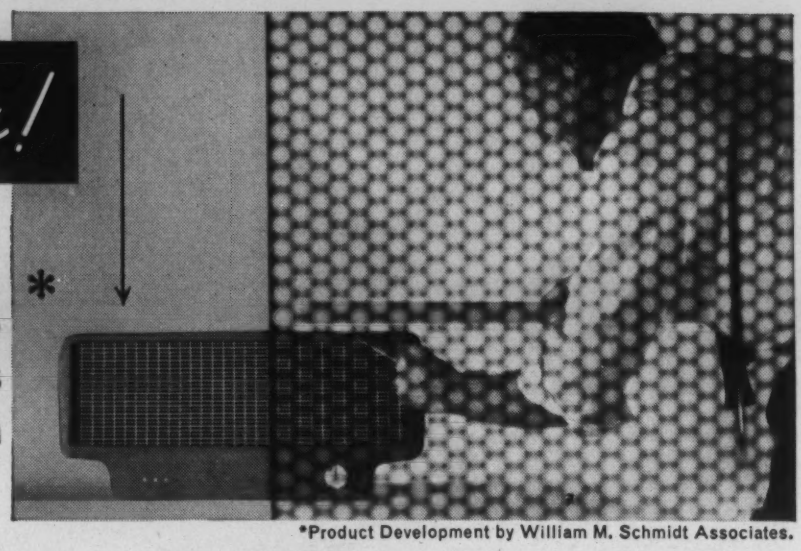
SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.
SANDUSKY, OHIO

For more information, turn to Reader Service card, circle No. 526

For more information, turn to Reader Service card, circle No. 398

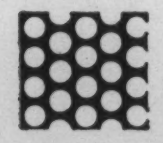
Idea!

mock-up projects design

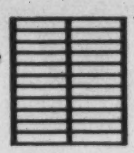


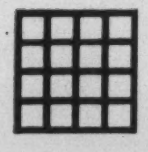
*Product Development by William M. Schmidt Associates.

with H & K perforated metals

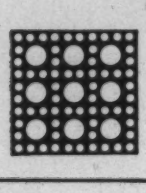


A few of the thousands of H & K patterns are illustrated in reduced size





Send today to nearest H & K office for General Catalog



Here is an H & K perforated metal grille utilized in a mock-up of a record player. This greatly helps the Industrial Designer project his concepts as H & K perforated metal is now in its proper element for consideration of use and selection of pattern.

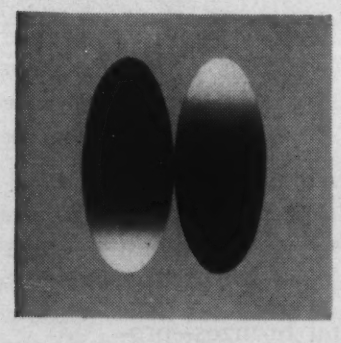
By referring to the H & K General Catalog, the designer can select one or more patterns for his project.

H & K perforated metals provide the Industrial Designer, and other men of ideas, a medium of unlimited opportunities for designing better and more attractive products.

THE Harrington & King PERFORATING CO. INC.

Chicago Office and Warehouse
5671 Fillmore Street
Chicago 44 Illinois

New York Office and Warehouse
[illegible] Liberty Street
New York, New York



Here's how you can keep up with

ADVANCED MATERIALS TECHNOLOGY

Today industry needs new materials and methods to solve problems of increasingly higher temperatures, nuclear power production and unusual conditions of corrosion and abrasion. "ADVANCED MATERIALS TECHNOLOGY" is a new publication devoted to developments in this important new field. It's "top priority" reading for engineers, designers and research men faced with overcoming the limitations of conventional materials. Published quarterly by Carborundum, Niagara Falls, N. Y.

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News OF INDUSTRY

advancement of knowledge and application of the sciences related to the technology of paint and allied products; 3) conduct short-term research aimed at developing products that will utilize paint; and 4) encourage technological education pertinent to the paint industry.

Dr. J. S. Long, formerly chemical director at Devoe & Raynolds Co., Inc., has been engaged as director of the new Institute.

Engineers

B. J. Fletcher has been elected vice president, Aluminum Co. of America.

William T. Cole, Canton Malleable Iron Co., won first prize in the 1958 Malleable Founders' Society "Redesign and Conversion Contest."

W. E. Gutzwiller has been appointed assistant to the manager, and **T. H. Bloodworth** has been named chief systems engineer, Electrical Application Dept., Allis-Chalmers Mfg. Co.

Edwin J. Duncan has been appointed metallurgical engineer, Latrobe Steel Co.

Dr. Leland M. White has been named director of research and development, U. S. Rubber Co.

Dr. Ira Kukin is now research director at the Belleville, N. J., plant, L. Sonneborn Sons, Inc.

Edward I. Brown has been appointed director of engineering, Machinery Hydraulics Div., Vickers Inc.

Peter C. Rossin has been appointed technical director, Refractomet Div., Universal-Cyclops Steel Corp.

Dr. Maurice F. Hasler, Applied Research Laboratories, has received the fourth annual Beckman Award for "outstanding contribution to the field of chemical instrumentation." The award, sponsored by Beckman Instruments, Inc., was presented at the 133rd national American Chemical Society meeting in San Francisco.

Frank J. Palermo has been named to the newly created position of director of manufacturing, J. I. Case Co.

Prof. H. U. Ross, University of Toronto, is the recipient of the *Journal of Metals* Award given by the Blast Furnace, Coke Oven and

News about **R&A Adhesives**

FOR ALL METALS AND ALL PLASTICS

Two ways to bond rigid 'styrene foams without fear of cell attack

❶ ***Low-cost, fast-grab, high strength no-residual-odor, rubber-resin adhesives.***

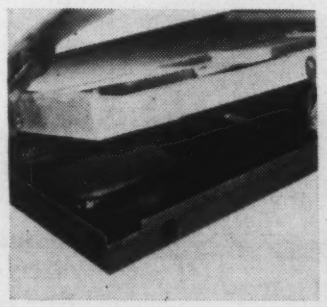
❷ ***100% reactive, solvent-free epoxies.***

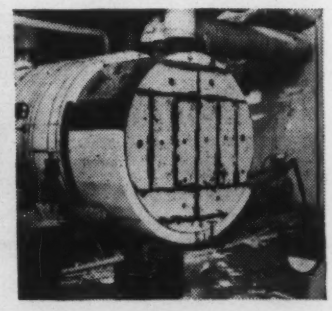
It doesn't take too much to collapse the cells of rigid polystyrene foams. You can do it with the pressure of your fingernail . . . or with the solvents used in most conventional adhesives.

That's why even the solvents used in our BONDMASTER® G458 Series adhesives had to be specially formulated. And it's this "built-in" avoidance of cell attack that has made R&A's "chemical fasteners" for foamed polystyrene so widely specified.

The low-cost G458 Series is offered in several viscosities to permit efficient application by notched trowel, spreader, spatula, "push box", or spray gun.

New, high strength, low cost adhesives permit swift economical bonding of all rigid polystyrene foams to themselves, to metals, wood, masonry, other plastics . . . for high efficiency, lightweight insulation . . . for building construction, industrial equipment . . . without fear of cell collapse.





"CUSTOM-TAILORED" DRYING TIME

Most formulations in the series let you combine immediately. Others permit extensive time delay between applying the adhesive and assembling the components.

Either way, they enable you to overcome the key problems involved in bonding these plastic foams to themselves or to metals, wood, cement board, or other materials, since all feature high strength, moisture-resistance; resistance to odor absorption and transmission (essential in refrigerator work), resistance to freezing temperatures; and long-time aging properties in the completed bond.

WHY SOLVENT-FREE EPOXIES?

You wouldn't suppose heat resistance mattered since the foam won't stand too much, itself. However, there are some installations (mostly military) where a void-filling adhesive must resist "creep" at temperatures up to the foam's softening point . . . and under structural loads, at that! For such applications, most foam manufacturers' literature recommend a 100%-solids epoxy such as BONDMASTER M664 or M688.

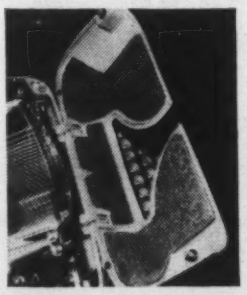
For technical data and samples of the rubber-resins or the epoxies tell us about your specific problems.

Working with "flexible" foams . . . ?

When it comes to "chemical fastening" flexible foams, the answers are not quite so clear-cut.

In 1947, R&A developed the first practical rapid tack-loss, one-part, fast-grab, soft-seam adhesive for foam rubber and our BONDMASTER R225 is still the leader in that industry.

And our most popular adhesive for vinyl foams (BONDMASTER C294) does an equally effective and economical job on that plastic...



Those "urethanes", though, are used so many different ways (to themselves, to metal, wood, fabric, grit, etc.) that the "best" formulation will depend not only upon the materials you are working with but upon the bond characteristics you consider most important.

We've over a dozen different formulations that are used to mass-production-bond urethane foams right now. One of these could very well be exactly what you are looking for.

Just detail your problem and we'll speed samples . . . without obligation of course.

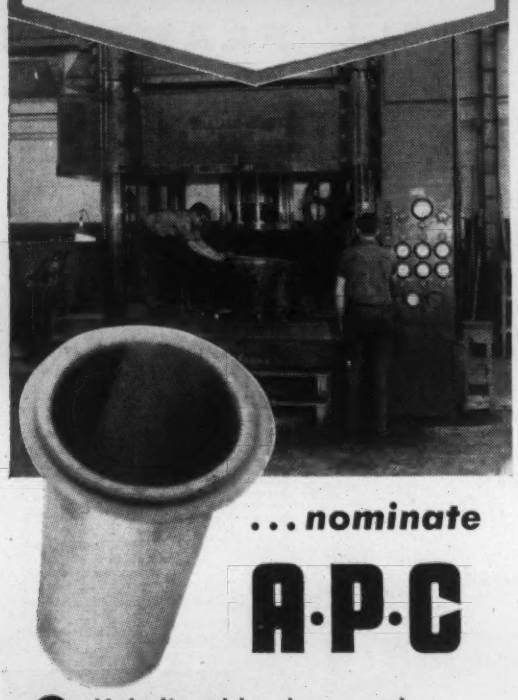
RUBBER & ASBESTOS
CORPORATION
227 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

For more information, turn to Reader Service card, circle No. 433

If you want a source for

Craftication*

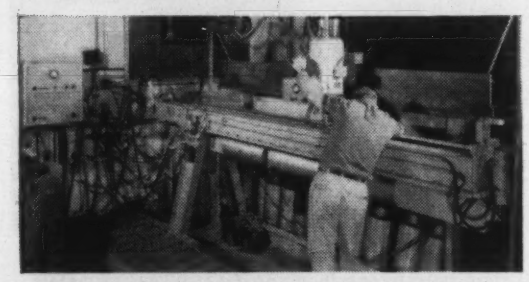
in Stainless Steel...



...nominate

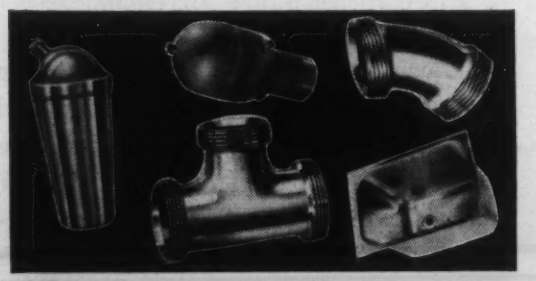
A·P·C

- Unbelievably deep and complex draws



- Specially designed heli-arc welding machines tailored for your product

- Large seam welding machines



- Experience in wide, wide range of products and components

Variety Versatility

*Craftication is our term for A-P-C's fabrication by skilled craftsmen

ALLOY PRODUCTS CORP.

1070 PERKINS AVENUE • WAUKESHA, WIS.

For more information, circle No. 557

News OF INDUSTRY

Raw Materials Committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

George W. Seagren has been named director of research, Stoner-Mudge Co.

James A. Glunt has been appointed chief metallurgist, Alan Wood Steel Co.

Edward J. Diebold is now director, Heavy Duty Product Dept., International Rectifier Corp.

William R. Johnson has been appointed assistant director of research and development, Associated Spring Corp.

Jack F. Greathouse, Mack Trucks, Inc., has received the Pressed Metal Institute's 1958 John Woodman Higgins Redesign Award.

Dr. Eugene S. Machlin, Columbia University, has been appointed acting director of research, Utica Metals Div., Kelsey Hayes Co.

Hiram P. Smith has been named manager of engineering, Farm Implement Div., International Harvester Co.

John Dersch has been promoted to general production manager, Coatings and Adhesives Dept., Borden Chemical Co.

Dr. Vladimir Hospadaruk is now research chemist, Research Laboratory, International Nickel Co., Inc.

Frank Kaman has been named chief air tool engineer; **Peter Rebechini,** chief electric tool engineer; and **James A. Perham,** chief product engineer, Aurora Works, Thor Power Tool Co.

Kenneth R. Eppele is now laboratory director, Wyle Research Corp.

Dr. Clyde E. Arntzen has been appointed manager, Materials Engineering Dept., Westinghouse Electric Corp.

Frank V. Wallack, Jr. has been named director of research, Westbury Electronics, Inc.

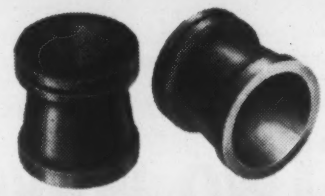
John R. Scholl has been appointed chief engineer, Nicad Div., Gould-National Batteries, Inc.

Angus MacDonald has been named director of engineering, Military Electronics Center, and Communications and Industrial Electronics Div., Motorola Inc.

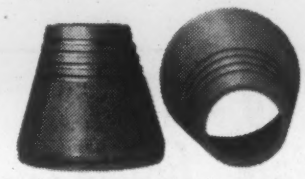
Keith R. Cranker has been appointed director of research and development, Plumb Chemical Corp.

(News of Companies on p 220)

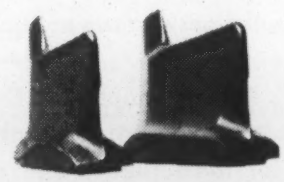
Choose the material that gets **stronger** when the heat's on!



√ solid-fuel rocket nozzle inserts



√ divergent cone sections



√ rocket vanes

SPEER GRAPHITE

Speer Graphite is the "machinable ceramic" that resists thermal shock, is chemically inert, doesn't warp, actually gets stronger as temperatures increase up to 5432°F. That's why it plays so many vital roles in rockets and missiles!

Close tolerances are easy to machine and *maintain* in parts made of Speer Graphite. Excellent thermal and electrical conductivity, capability of impregnation with fluids, or of coating with metals and non-metals, and self-lubricating qualities add to the usefulness of Speer Graphite. If your parts require these, and other important high-temperature characteristics, Speer Graphite is the answer. Mail the coupon for the whole story.

SPEER Carbon Co. St. Marys, Pa.

Please send information on carbon for use in

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Title_____

Company_____

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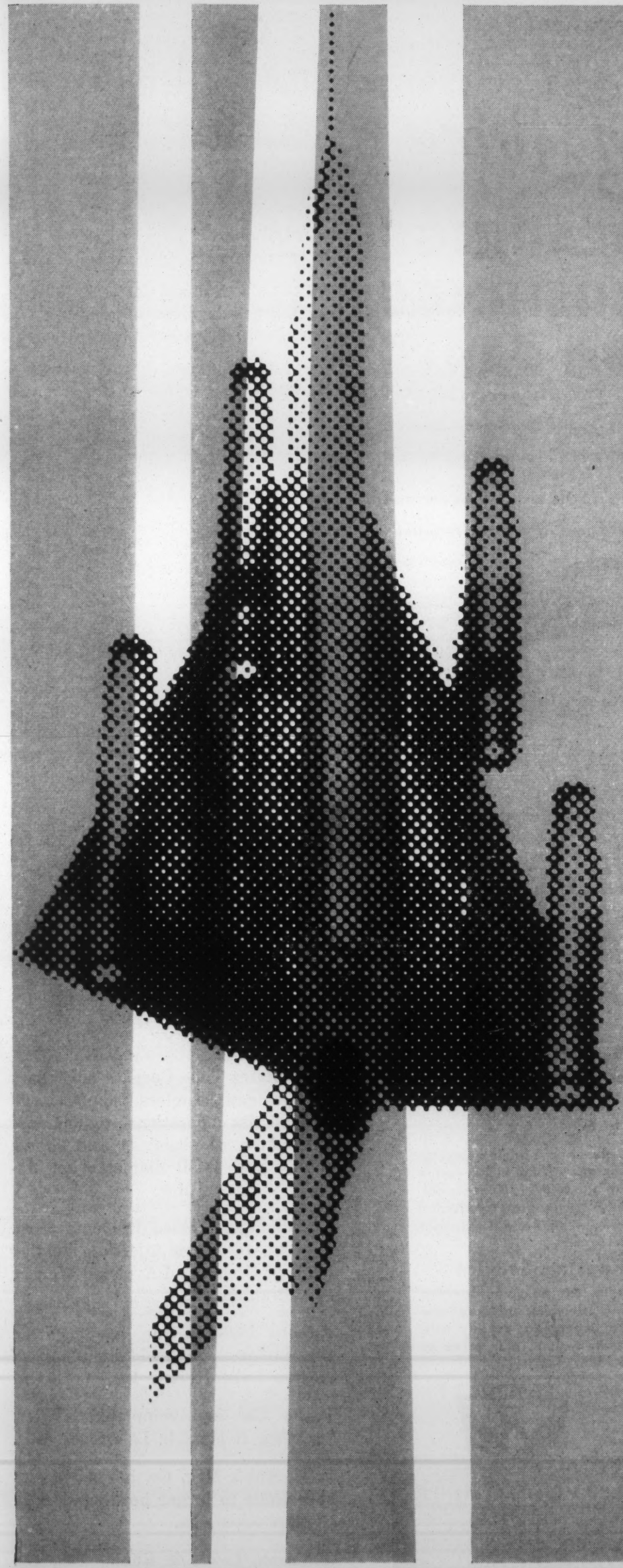

WORLD'S HOTTEST jet bomber flies real cool. When it comes to supersonic flight the speed limit is set by aerodynamic heat. That's why heat-resistant glass fabric honeycomb made of Trevarno glass fibre sandwiched between metal skins — helps give Convair's B-58 Hustler speed unmatched by any other bomber. Trevarno glass fabric honeycomb is so successful in reducing internal temperature, this material in the bomber's wings has been termed "one of the most vital achievements in recent years" by Air Force officials. Even though the material is a major break-through for the B-58, more important, it paves the way for new missile development and for even more advanced aircraft in the future. Write today for data on Phenolic, Epoxy, Silicone, Polyester resin systems, or on custom impregnations for special applications. High glass moulding compounds in above resin systems also available. For further information contact Coast Manufacturing & Supply Company, P.O. Box 71, Livermore, California. Sales Offices: 4924 Greenville Avenue, Dallas, Texas; 635 South Kenmore, Los Angeles, Calif.

Trevarno
GLASS FABRICS

COAST MANUFACTURING AND SUPPLY COMPANY. P.O. BOX 71, LIVERMORE, CALIFORNIA. PLANTS AT LIVERMORE, CALIFORNIA AND SEGUIN, TEXAS

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Fastest Service on
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WEARING PARTS
of any size, shape or section. Rough cast or machined to precisely controlled tolerances. Difficult oil grooving . . . smooth even around acute bends.
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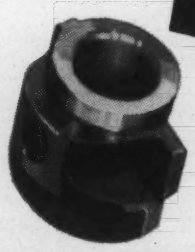
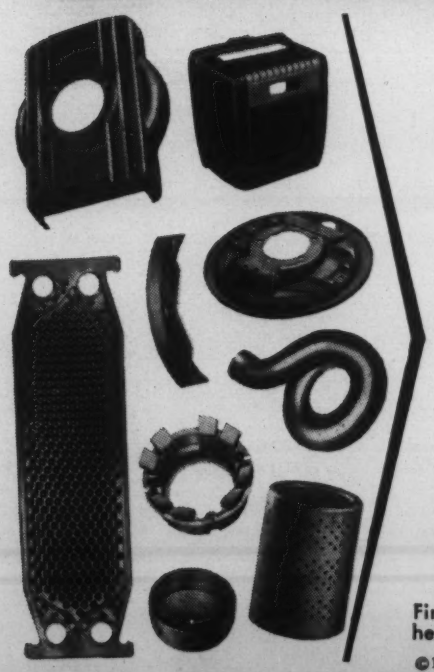
Inquire About Promet Fully Machined CORED & SOLID BRONZE BAR STOCK Saves Time, Tools & Money!



THE American Crucible PRODUCTS CO.
1325 Oberlin Avenue
Lorain, Ohio, U.S.A.

Production costs too high?
BOSSERT METAL STAMPINGS
offer many ways to reduce costs!



Whether your product is in the planning stage or in production, you can often reduce costs by using metal stampings for parts or complete assemblies. Complex forms can usually be produced with fewer operations, with holes punched to exact dimensional accuracy, eliminating separate drilling, machining and assembling.

Several parts can be combined in a single stamping, and you can take advantage of the weight-saving features of lighter metals and alloys without sacrificing strength or durability. Your present production costs can be reduced, too, with Bossert's superior quality and dependable service.

Design Engineering Service

Bossert's re-design service can help you develop stampings for parts and assemblies that are now being cast or forged or machined, usually with substantial savings in cost. Send us blue prints or samples for our recommendations.

Write for literature
Find out how our facilities can be helpful to you.

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ROCKWELL R STANDARD ®

ROCKWELL-STANDARD CORPORATION
STAMPING DIVISION
1010 OSWEGO STREET UTICA, NEW YORK

For more information, turn to Reader Service card, circle No. 502

News of Industry

Companies

Alan Wood Steel Co. is building a 50-ton-per-day iron powder plant at Ivy Rock, Pa.

Packaging and Product Development Institute Inc. is the name of a new industrial design organization established in Cincinnati, Ohio.

Switchcraft, Inc. is moving to new quarters at 5555 N. Elston Ave., Chicago.

Robertshaw-Fulton Controls Co.'s Fielden Instrument Div. is now called the Instrument Division.

Duramic Products, Inc. is the new name of **Technion Design & Mfg. Co., Inc.**

Commonwealth Plastics Corp. has recently opened a Dielectric Products Div. for the fabrication of components for the electronics industry.

Rubbermaid, Inc. is the new corporate name of **Wooster Rubber Co.**

Harvey Aluminum is the new name of **Harvey Machine Co., Inc.**

Clarke Sanding Machine Co. has purchased **Modern Power Sweeper Co.**

Acoustica Associates, Inc. has opened a new plant at 11601 W. Jefferson Blvd., Culver City, Calif.

Gulf States Tube Corp., a subsidiary of Michigan Seamless Tube Co., will expand its operations to increase production of seamless cold drawn tubing and small diameter hot finished seamless pipe.

Consolidated Molded Products Corp. has opened a new injection molding plant at Greenwood Ave. and Warner St., Scranton, Pa.

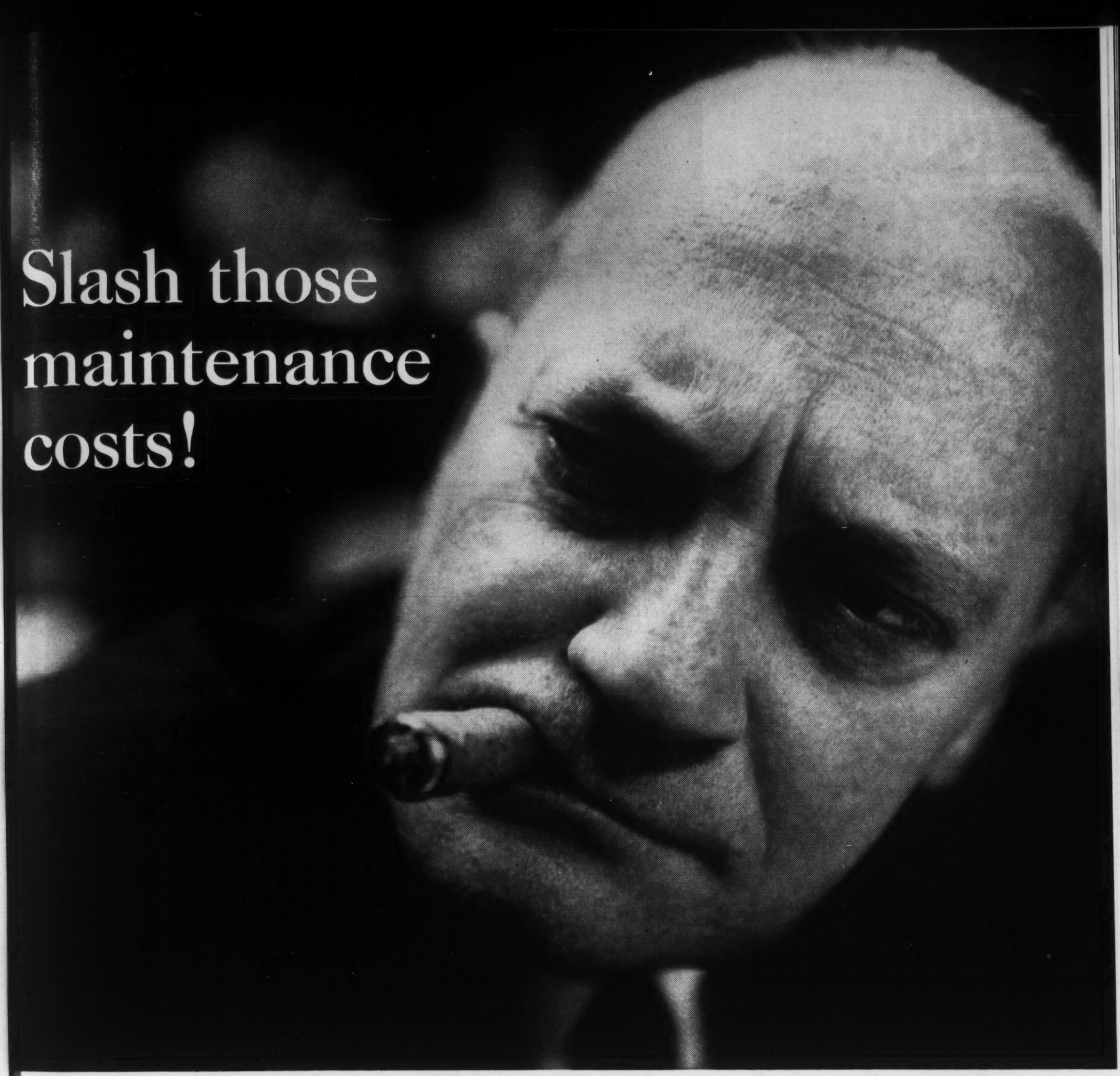
Auburn Plastics, Inc. has acquired the compression molding plant of **Norton Laboratories, Inc.**

Trane Co. has completed a new 76,800-sq ft plant in La Crosse, Wis.

E. C. Smith Mfg. Co. has moved its operations to larger headquarters in Conshohocken, Pa.

Robinson, Lewis & Rubin, Inc., 132 Lafayette St., New York 13, is a new

For more information, circle No. 510 >



try titanium now!

Mounting competitive pressure makes reduced maintenance costs essential. More and more companies are easing this pressure with titanium—now readily available. Only titanium combines unique corrosion resistance with high strength-weight-ratio and works equally as well in valves and pipes as in complex components.

But there are even more compelling reasons for trying titanium *now*. Its strength and lightness can affect the size, performance and durability of equipment. It takes *continuous* temperatures up to 800 deg. F. and flash heats up to 2,000 deg. F., where other metals lose strength rapidly above 250 deg. F.

These or other characteristics of titanium could well be the answer to your most puzzling maintenance or production problem. Only by putting it to work on your process can you discover all the benefits that titanium can bring to you. Try it and see!

GET UP-TO-DATE ON TITANIUM

Booklet gives cost saving service records. Tells where you can get titanium mill products and fabricated equipment now.

Electromet
FERRO-ALLOYS AND METALS

UNION CARBIDE

The terms "Electromet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

ELECTRO METALLURGICAL COMPANY ME-6
Division of Union Carbide Corporation
30 East 42nd Street, New York 17, N. Y.

Please send me a copy of "New Heat on Titanium."

*Name*_____

*Company*_____

*Address*_____

What is— "MOLDED FIBER GLASS"?

It's fiberglass reinforced plastic, custom molded by the affiliated MOLDED FIBER GLASS Companies.

It's one of the strongest, most durable materials known — a formulation of glass fibers and polyester resin possessing many superior physical features and infinite design possibilities.

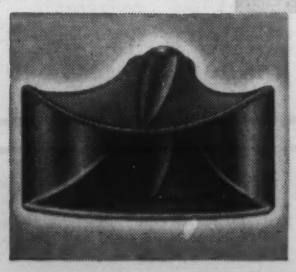
When skillfully molded by the exclusive MOLDED FIBER GLASS process (using made-to-fit preforms and matched metal dies), it forms products which do the job **better**, last longer, and are often more economical to produce.

The affiliated MOLDED FIBER GLASS Companies are pioneers in and world's largest producers of mass-produced fiberglass reinforced plastic parts.

If you are looking for ways to make a better product, at less cost — investigate MOLDED FIBER GLASS. Consultation with MOLDED FIBER GLASS engineers entails no cost or obligation. Write for new engineering handbook.

Beautiful, rust and corrosion-resistant planters

Strong, lightweight business machine housings



Molded Fiber Glass horns address the world

Molded Fiber Glass Company

4421 Benefit Avenue, Ashtabula, Ohio

For more information, circle No. 382

News OF INDUSTRY

corporation engaged in vacuum and low pressure forming.

International Steel Co. has acquired **Lindsay Structure, Inc.**

Law Engineering Testing Co. is the new name of **Law-Barrow-Agee Laboratories, Inc.**, Atlanta, Ga.

Brush Beryllium Co. has purchased the assets of **Penn Precision Products, Inc.**

Unexcelled Chemical Corp. has acquired the **Jasco Aluminum Products Corp.**

LeCount Tool Works, Inc. has moved to its new building at 38 Cody St., West Hartford, Conn.

Air Reduction Sales Co. has acquired **Adelson-Werts, Inc.**

CG Electronics Corp. has completed an expansion program which increases production facilities by five times.

Bardon Corp., manufacturer of ball bearings, has begun construction of a $2 million plant in Danbury, Conn., which will add 215,000 sq ft to manufacturing facilities.

L. A. Young Spring & Wire Corp. has purchased the assets and manufacturing rights of **Link Radio Corp.**

Swift & Co. has expanded its solvent adhesive manufacturing facilities by adding a new manufacturing plant located in Hammond, Ind.

Dow Chemical Co. is building a multimillion dollar plant to produce linear polyethylene.

Consolidated Molded Products Corp. has occupied a new plant at 498 Conklin Ave., Binghamton, N. Y.

Reynolds Metals Co. is building a $6 million research and office building in Richmond, Va.

Instrument Specialties Co.'s newly expanded plant in Little Falls, N. J. is now in full production.

Magnetic Instruments Co. has completed a move of all its operations to a new plant at 546 Commerce St., Thornwood, N. Y.

Chemetron Corp. is the new name of National Cylinder Gas Co.

(News of Societies on p 224)

TUBING

.010" TO 1.000" O.D. PRECISION QUALITY REGULAR MILL PRICES

Whatever the size, shape or alloy there's a Precision Tube to meet your requirements . . . made to precision specifications yet costs only regular mill prices. Round, rectangular, oval or square, preformed to special shapes . . . in copper, brass, aluminum, nickel, and nickel-alloys, Ni-Span "C", phosphor-bronze and nickel silver.

For improved quality at lower costs specify Precision Tubing. It is the tubing consistently unequalled and unsurpassed in comparative quality tests of accuracy, temper, straightness and roundness. It is yours at no extra cost.

Whatever your product plans you can rely on Precision for finish, accuracy and quick deliveries. For information on small tubing and specifications to use in selecting tubing write for the new data book to Department #6, Precision Tube Company, North Wales, Pa.

GET YOUR FREE COPY OF THIS DATA BOOK

PRECISION TUBE COMPANY

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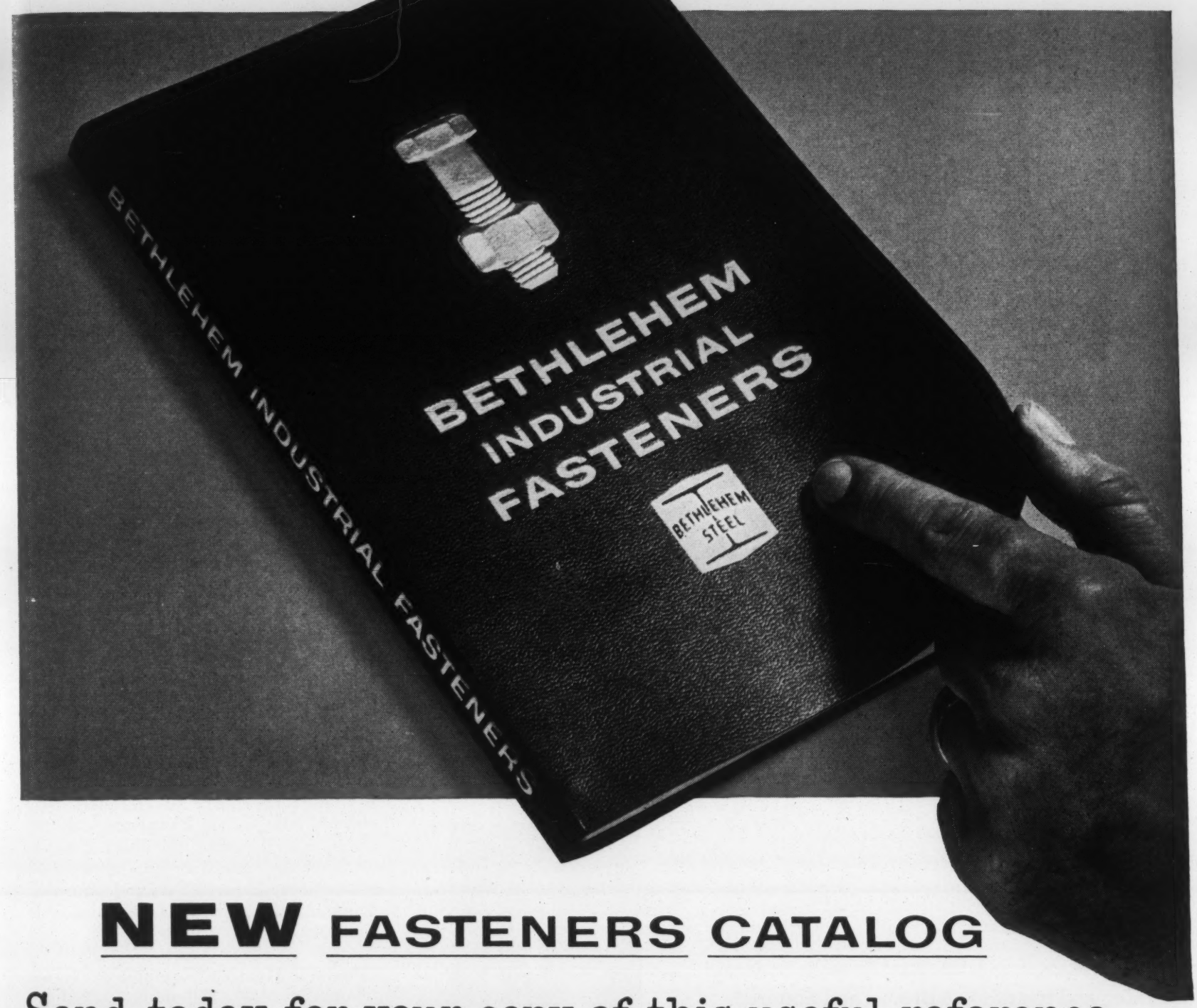

NEW FASTENERS CATALOG

Send today for your copy of this useful reference, the most complete edition ever issued!

Bethlehem has just issued "Industrial Fasteners," an illustrated catalog on headed and threaded fasteners. Handsomely bound, this 164-page catalog is attractively printed in two colors; and it is packed with data on just about every type and size of fastener imaginable. List prices, dimensions, weights, and container quantities are also included.

If you have not yet received your copy, use the accompanying coupon. Simply print your name and address, clip the coupon, and mail it direct to us at Bethlehem, Pa.

Publications Department, Room 1042
Bethlehem Steel Company
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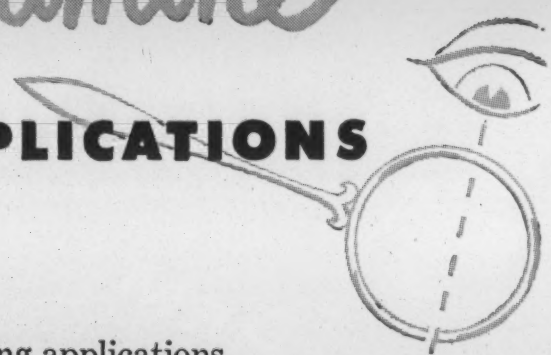
time to re-examine

BEARING APPLICATIONS



Striking cost reductions in bearing applications in many mechanical products are made possible by the use of Bunting Sintered Powdered Metal Bearings and parts.

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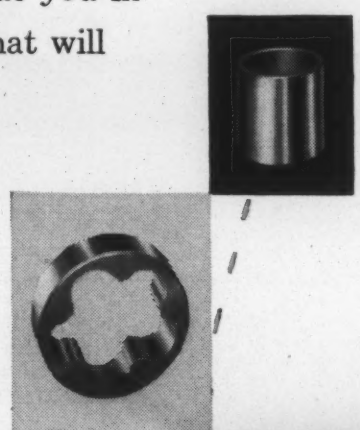
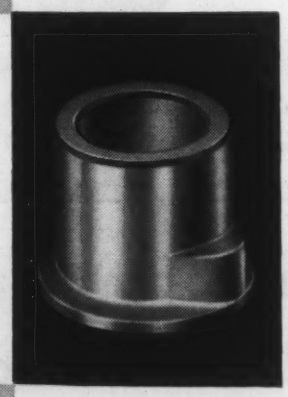
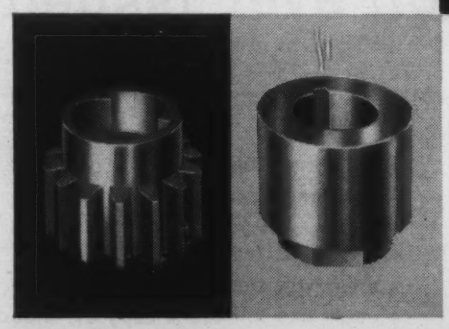


A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.



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News OF INDUSTRY

Societies

American Society of Heating and Air-Conditioning Engineers has elected the following officers: president—Elmer R. Queer, Pennsylvania State University; first vice president—Arthur J. Hess, Hess-Greiner & Polland; second vice president—Walter A. Grant, Carrier Corp.; and treasurer—John H. Fox, Honeywell Controls, Ltd.

Society of Die Casting Engineers, Inc. has elected the following national officers: president — Harry Cagin, Halex Die Casting Co.; vice president—Dean L. Rockwell, Clifford-Rockwell Co.; and secretary-treasurer — Mayer R. Tenenbaum, Lester-Phoenix, Inc. Directors are: William Van Raaphorst, American Mold Engineering Co.; Harris R. Shimel; John Lapin, Saginaw Bay Industries, Inc.; and Herman J. Windolph, Holland Die Casting, Inc.

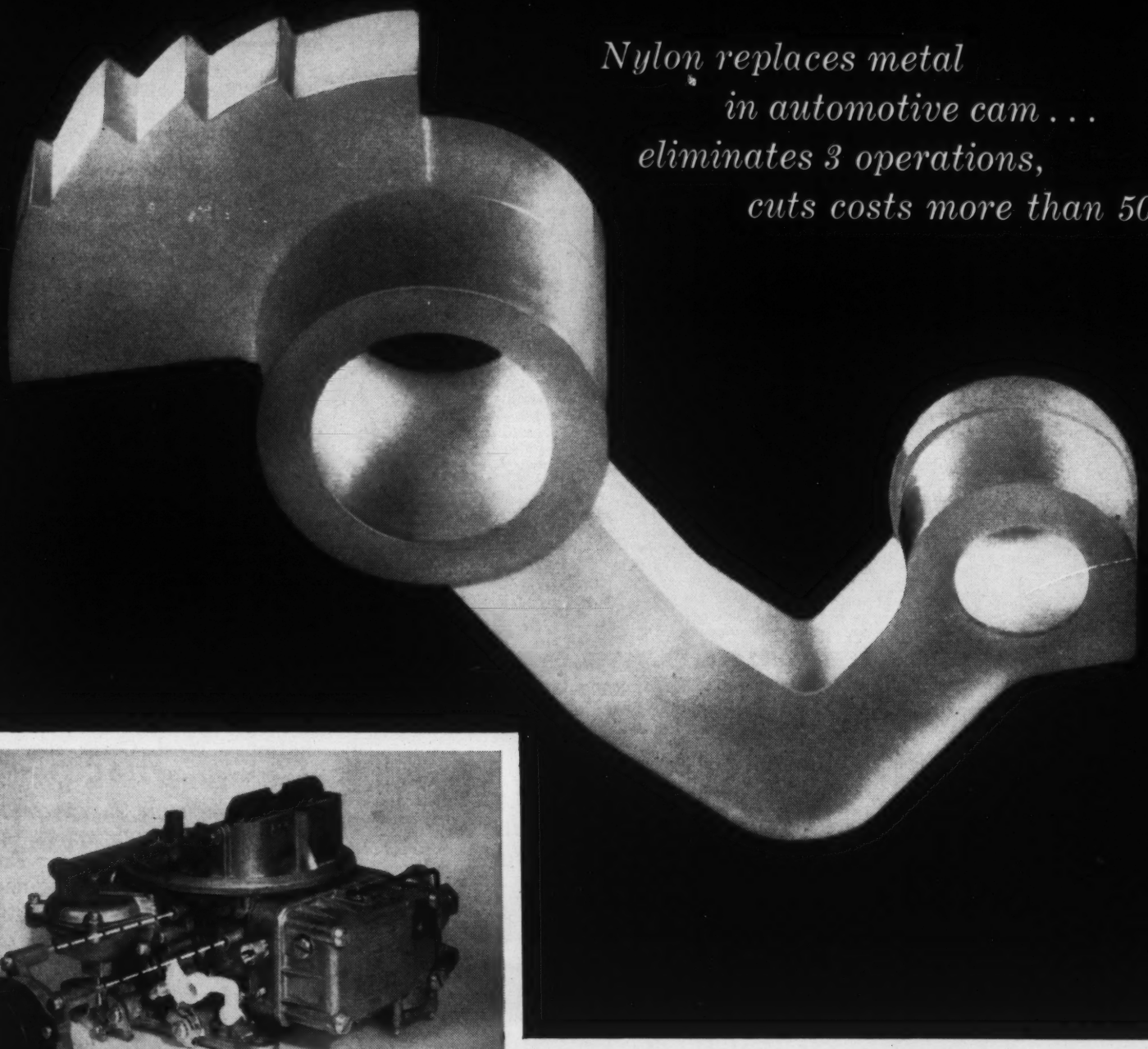
American Standards Assn. announces the following 1958 officers: president—H. Thomas Hallowell, Jr., Standard Pressed Steel Co.; and vice president—John R. Townsend, Office of Assistant Secretary of Defense. Directors are: J. C. Lawrence; M. J. Pitre, Fidelity and Casualty Co. of New York; Richard W. Summey, Bridgeport Brass Co.; and Harold R. Huntley, American Telephone and Telegraph Co.

Industrial Heating Equipment Assn. announces the following officers: president—C. Floyd Olmstead, Lee Wilson Engineering Co.; vice president—R. L. Harper, Harper Electric Furnace Corp.; treasurer—Ralph E. Whittaker, Swindell-Dressler Corp.; executive vice president—Robert E. Fleming; and executive committee member—A. E. Tarr, Leeds & Northrup Co.

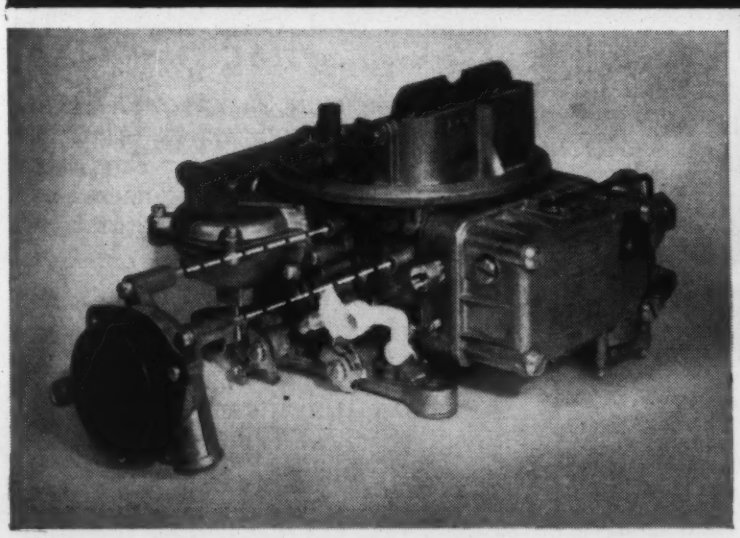
Aluminum Assn. announces the following officers: president—S. D. Den Uyl, Bohn Aluminum & Brass Corp.; chairman, board of directors—Everett G. Fahlman, Permold Co.; directors-at-large — Irving Lipkowitz, Reynolds Metals Co.; Louis Lippa, Apex Smelting Co.; D. A. Rhoades, Kaiser Aluminum & Chemical Corp.; vice presidents—Frederick A. Merliss, United Smelting & Aluminum Co.; Russel B. Caples, Anaconda Aluminum Co.; and Frank R. Nichols, Nichols Wire & Aluminum Co.

(News of Meetings on p 226)

Here's the new nylon idling cam produced by Chicago Molded for Holley Carburetor



Nylon replaces metal in automotive cam . . . eliminates 3 operations, cuts costs more than 50%



Many models of Ford Motor's Lincoln, Mercury and Edsel are equipped with latest-type Holley automatic carburetors. In inset photo, choke housing has been pulled away to show the molded nylon fast-idle cam as assembled.

This nylon fast-idle cam made by Chicago Molded for Holley offers less friction, and resists wear better than cams of low carbon steel. Furthermore, injection-molding it of nylon eliminates three operations – hardening, stamping, assembly – at production savings of more than fifty percent.

Holley is able to change the cam design without obsoleting the entire mold. That's because Chicago Molded designed a unique multiple-cavity mold made with removable sections. This permits easy changes in the number and sizes of the ratchets with very little expense, when the basic part is redesigned.

Designing and making molds that cut costs – and allow for low-cost changes – is a specialty of Chicago Molded's engineering staff. Why not find out if they can cut your costs? Ask, too, for a free subscription to *Plastics Progress* – the data-packed magazine on new developments in plastics. Write:

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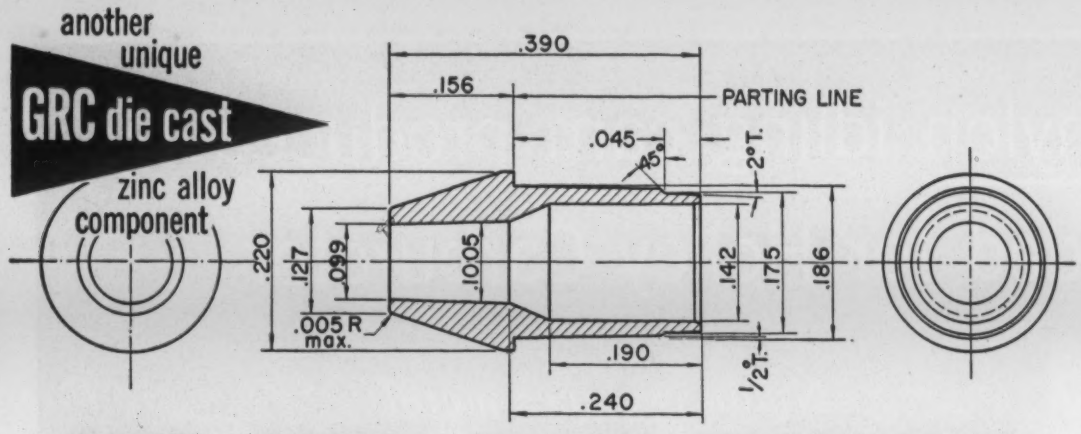
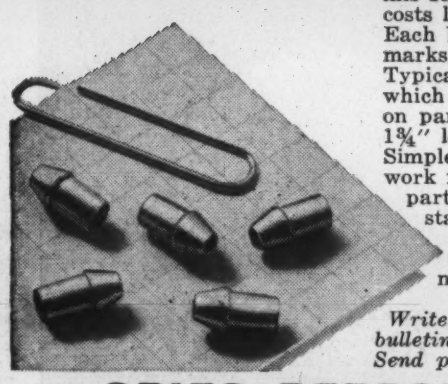


GRC CUTS TINY BUSHING COST TO $2.00 / M

Die cast by GRC in zinc alloy in a single automatic operation, this former screw machine part for a ball point pen, now costs little more than $2.00 per thousand in lots of a million. Each bushing is uniform, clean and accurate—no cut-off marks, no burrs, no secondary trimming and no scrap loss. Typical of the production economies and wide design latitude which GRC's exclusive patented methods have made possible on parts "no bigger than your thumbnail!" (Maximum size is 1¾" long, ½ oz.; no size too small).

Simple or complex, let GRC's unique techniques go to work for you . . . on tiny die cast *and plastic molded* parts made to order . . . on their wide variety of standard parts available in stock—die cast wing and round head thumb nuts and screws, cap nuts, gears and pinions, molded nylon screws-you'll be glad you did.



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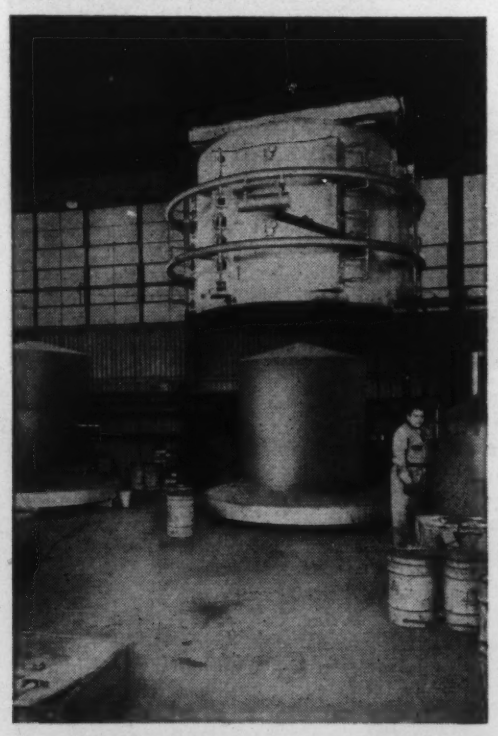
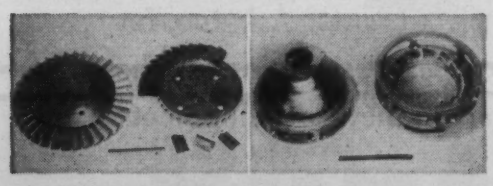
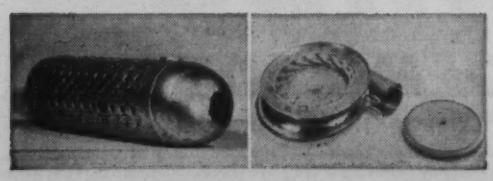


The 72-inch dia. hydrogen atmosphere furnace being lowered over a loaded furnace bell. Detroit plant.



Brazed stainless steel and titanium alloy parts are strong, undistorted, and bright and free of oxides.



If you are planning the manufacture of stainless alloy assemblies, you should check our facilities and skills for

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You'll find our up-to-the minute facilities and years of experience can help you in your stainless steel brazing and heat treating. All three of our plants are equipped with pure dry hydrogen atmosphere furnaces, and are manned by skilled engineers. They are also pioneers in the use of Nicrobraz, the stainless brazing alloys that have the strength and corrosion resistance of stainless steel at 2000° F.

Vacuum-type furnaces are used in the Detroit plant for silver brazing complex titanium alloy assemblies. Our fluxless process provides high joint shear strength with no distortion, oxidation, or loss of ductility. Heat treating and degassing of titanium alloy parts is also done. Contact us for more information.

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News of Industry

Meetings

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City. June 8-13.

MALLEABLE FOUNDERS' SOCIETY, annual meeting. Hot Springs, Va. June 9-10.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Detroit. June 15-19.

ALLOY CASTING INSTITUTE, annual meeting. Hot Springs, Va. June 21-24.

AMERICAN SOCIETY FOR TESTING MATERIALS, 61st annual meeting and apparatus exhibit. Boston. June 22-28.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer general meeting. Buffalo, N. Y. June 23-27.

SOCIETY OF THE PLASTICS INDUSTRY, INC., Midwest section conference. French Lick, Ind. June 26-27.

SOCIETY OF AUTOMOTIVE ENGINEERS, national West Coast meeting. Los Angeles. Aug 11-14.

CONFERENCE ON ELECTRONIC STANDARDS AND MEASUREMENTS, American Institute of Electrical Engineers, Institute of Radio Engineers and National Bureau of Standards. Boulder, Colo. Aug 13-15.

WESTERN ELECTRONIC SHOW AND CONVENTION, Wescon. Los Angeles. Aug 19-22.

AMERICAN CHEMICAL SOCIETY, national chemical exposition and conference. Chicago. Sept 7-12.

SOCIETY OF AUTOMOTIVE ENGINEERS, national farm, construction and industrial machinery meeting, and production forum and display. Milwaukee, Wis. Sept 8-11.

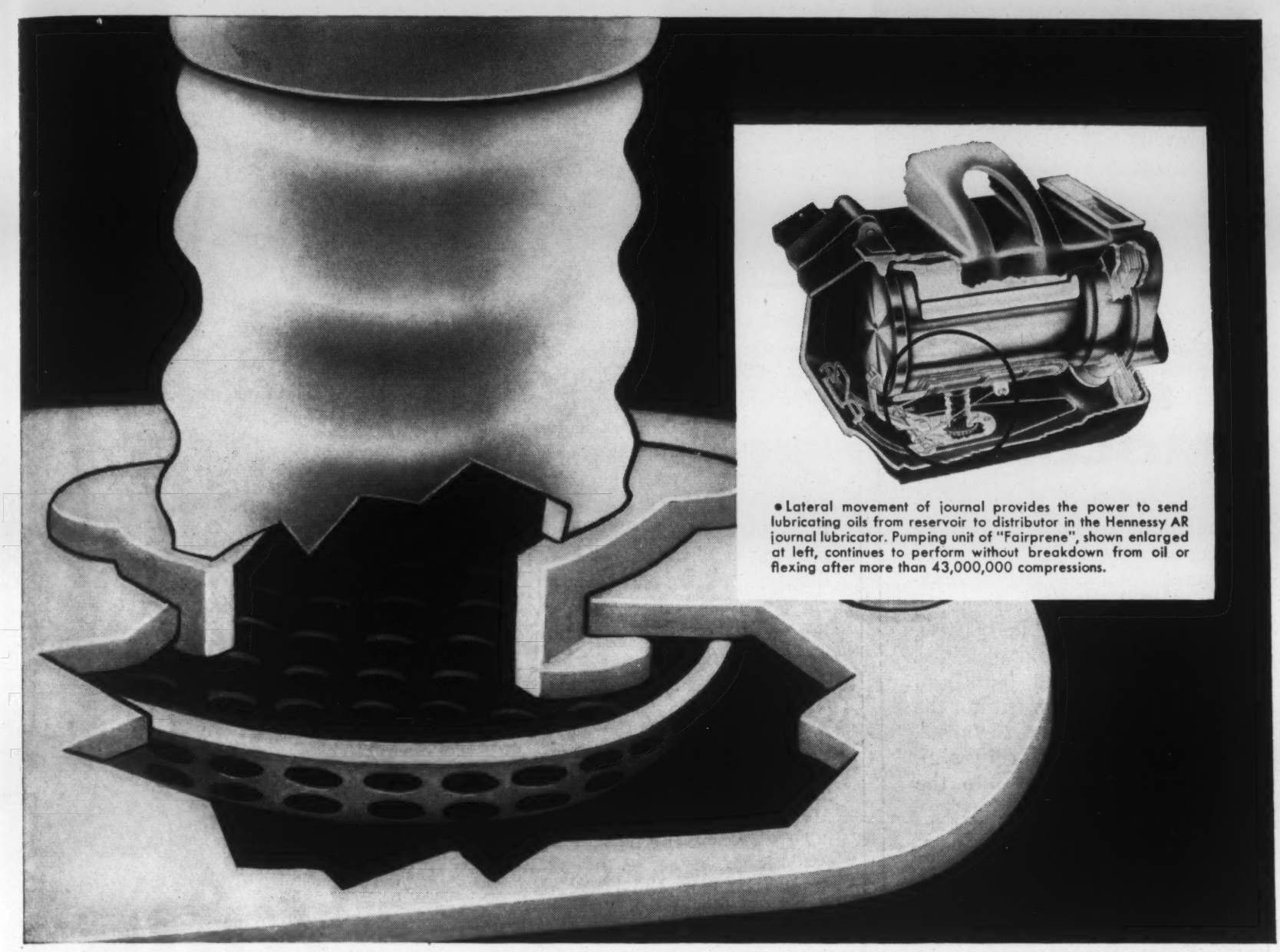
AMERICAN DIE CASTING INSTITUTE, annual meeting. Chicago. Sept 10-11.

AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS, INC., Rocky Mountain minerals conference. Salt Lake City. Sept 10-12.

AMERICAN ROCKET SOCIETY, INC., fall meeting. Detroit. Sept 14-18.

INSTRUMENT SOCIETY OF AMERICA, 13th annual instrument automation conference and exhibit. Philadelphia. Sept 15-19.

STEEL FOUNDERS' SOCIETY OF AMERICA, 56th fall meeting. Hot Springs, Va. Sept 22-23.



• Lateral movement of journal provides the power to send lubricating oils from reservoir to distributor in the Hennessy AR journal lubricator. Pumping unit of "Fairprene", shown enlarged at left, continues to perform without breakdown from oil or flexing after more than 43,000,000 compressions.

Lubricating pump of Du Pont FAIRPRENE® strong and flexible after more than 43,000,000 compressions!

Tested continuously for 36 months, the equivalent of 500,000 miles of actual freight-car journal-box service, this lubricating pump of "Fairprene"* is still in good condition! That's why Hennessy Lubricator Co., Inc., plans to guarantee it for life.

This is an example of the high-level performance you can expect from "Fairprene". In addition, Du Pont technical assistance can help you select materials resistant to gas, oils, solvents or corrosive chemicals, abrasion, and flex cracking—materials that withstand temperatures from –100°F. to 500°F. . . . or possess superior insulation or anti-stick properties. Whatever your special needs, you can get the facts about Du Pont industrial coated fabrics. Simply fill out and mail the coupon.

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†*"Dacron" is Du Pont's registered trademark for its polyester fiber*

**Fairprene" is Du Pont's registered trademark for its coated fabrics, sheet stocks and cements.*

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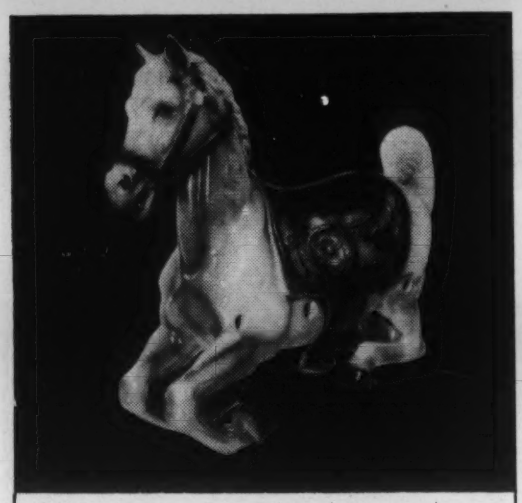

SLUSH MOLDING

REYNOSOL Slush Molding formulations are being used in an increasingly large variety of operations which include mannequin heads and neck pieces, baby doll head and body parts, electrical parts, and novelties. Typical undercuts found on slush moldings present not the slightest problem to Reynosol, thanks to special releasing agents incorporated into the formulation.

COLOR	UNLIMITED
COST	COMPETITIVE WITH RUBBER OR OTHER FILM-FORMING MATERIALS
AGING PROPERTIES	GOOD
LIGHT RESISTANCE	GOOD
TYPE OF SURFACE	DRY AND GLOSSY
TENSILE STRENGTH	VERY GOOD
SCUFF RESISTANCE	VERY GOOD
ABRAISON RESISTANCE	VERY GOOD
ALKALI RESISTANCE	VERY GOOD
ACID RESISTANCE	VERY GOOD
OIL RESISTANCE	VERY GOOD
HARDNESS	AS HIGH AS 95 (SHORE-A)
% FILM FORMING	100%
VISCOSITY	2,000 TO 4,000 CPS.
TEAR RESISTANCE	GOOD
FIRE HAZARD	NONE

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(cont'd from p 49)

Books

Handbook of Aluminum. *Aluminum Co. of Canada, Ltd., Montreal. 1957. Cloth 6 by 9 in., 279 pp. Price $3*

The aim of the book is to describe aluminum and its alloys, how they are produced, and the principal industrial processes for working and finishing them. The eight chapters, illustrated with charts and graphs, discuss: physical, mechanical and corrosion resistance properties; joining and finishing; aluminum wrought products and castings; heat treatment; and machining and forming.

Symposium on Radiation Effects on Materials: Volume I. *ASTM Special Technical Publication No. 208, American Society for Testing Materials, Philadelphia, 1957. Cloth, 6 by 9 in., 195 pp. Price $4.75*

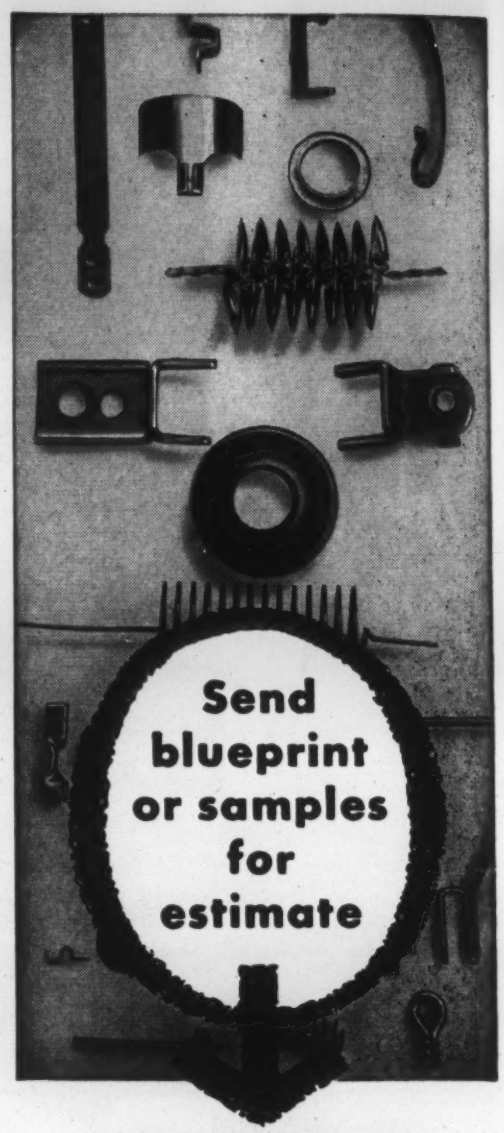
First of a series of symposium publications on the effect of radiation on materials, the present volume is concerned with the theory of radiation; the mechanics of testing irradiated materials; radiation effects on welds and notches in plain carbon and stainless steels and nonferrous alloys; effect of irradiation on some plastics and elastomers; fast neutron effects on tensile and hardness properties of type 347 stainless steel; and effects of neutron bombardment on structural materials.

Much of the information presented in the book was developed over the past ten or more years and kept in classified files until now. The book also contains a great deal of new information that has been made available recently. Since new information on the effects of radiation on materials will continue to flow in, the ASTM believes additional symposia on this subject are definitely indicated.

The Metallurgy of Vanadium. *Dr. William Rostoker. John Wiley & Sons, Inc., New York. 1958. Cloth, 6 by 9 in., 194 pp. Price $8.50*

High purity vanadium seems to have many potential uses as an alloy addition for both ferrous and nonferrous metals. It is the object of this book to make known the various properties of vanadium and to excite further investigations into its potential usefulness.

The book gives a host of properties on the metal, including thermal, electrical, magnetic, elastic, tensile,



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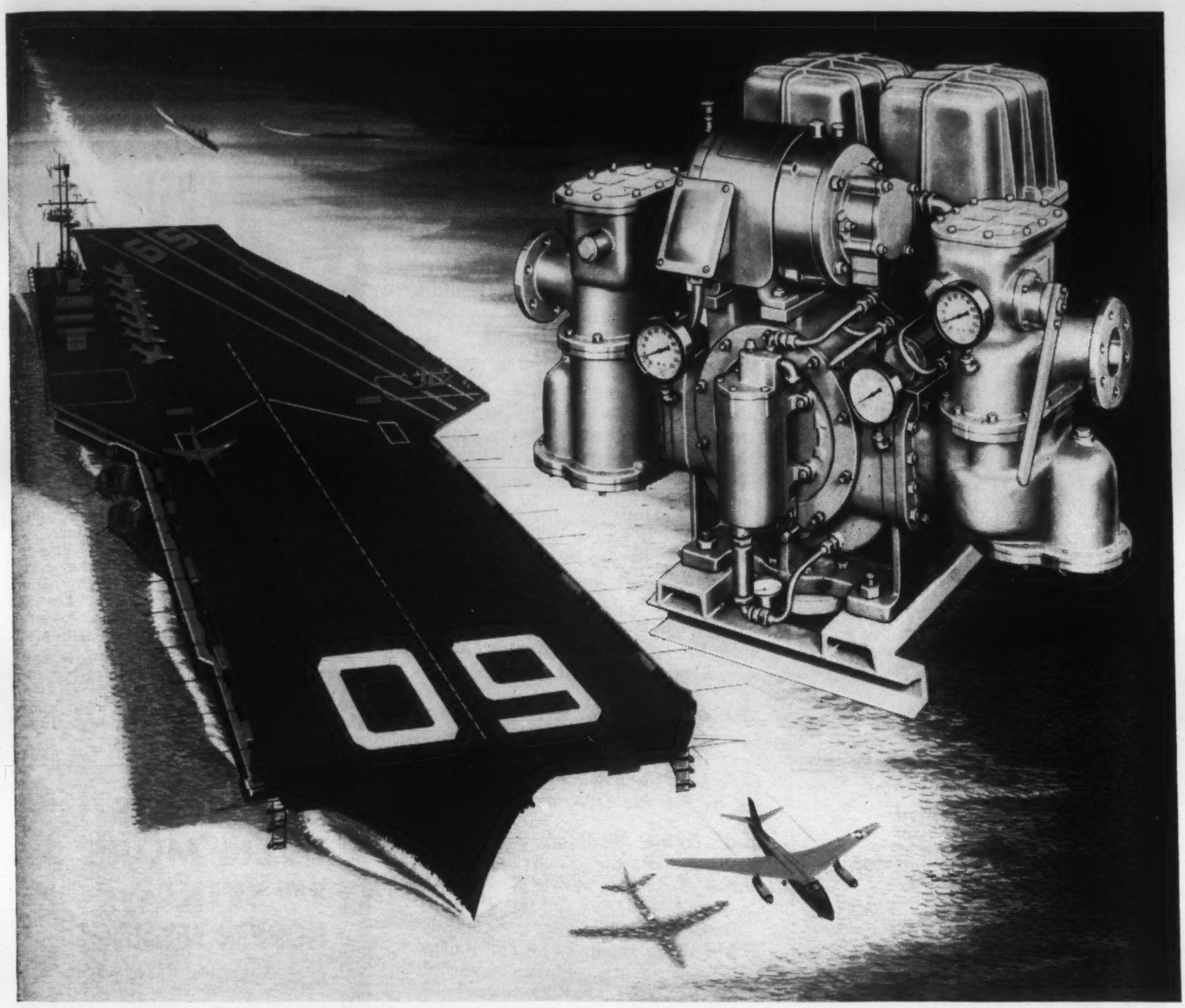

How Kanigen® coating helps eliminate rust from jet fuel systems

Fuel systems engineers faced a major problem in corrosion when jet aircraft went to sea. Aircraft carrier systems for fueling planes are aqua-systems—which means that to prevent accumulation of explosive vapors in half-empty tanks, water replaces fuel as it is pumped out of the carrier storage tanks. Blackmer fueling units, made by Blackmer Pump Company in Grand Rapids, Michigan, frequently are used.

High test aviation gasoline does not absorb moisture. Jet fuel does. This moisture, with high salt content, reaching unprotected steel castings, created rust which contaminated the fuel and caused malfunctioning.

Blackmer pumping units, made from steel castings to meet high shock requirements, were protected with KANIGEN® nickel-alloy coating. They were used and evaluated at sea for two years.

The KANIGEN coating was found superior because (1) it gave better initial overall coverage, and (2) the KANIGEN coating did not chip or break away from machine surfaces as some other coatings do.

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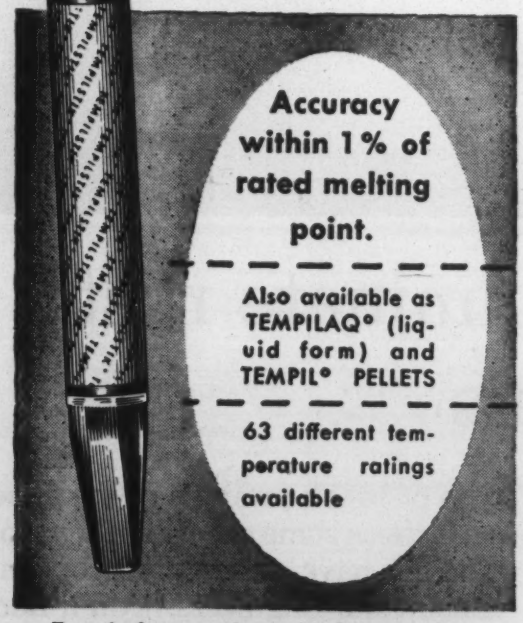

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TECHNICAL LITERATURE

creep, hot tensile and stress-rupture. Of particular interest is a chapter on the use of vanadium as an alloy addition in steel, cast iron, titanium alloys, magnetic alloys and high temperature alloys. Other topics of interest are casting, forging, extruding, welding, machining, electroplating and annealing of vanadium and its alloys; corrosion, oxidation and embrittlement of vanadium; and metallography of vanadium and its alloys.

Each chapter is illustrated with tables, graphs and photomicrographs and contains a list of articles pertaining to a particular aspect of vanadium. The author is associated with the Metals Research Dept. of the Armour Research Foundation.

FBI Register of British Manufacturers: 30th Edition. *Iliffe & Sons Ltd. and Kelly's Directories Ltd., London, England, 1958. Cloth, 7½ by 9½ in., 1138 pp. Price $5.90*

Zinc Oxide Rediscovered. *Prepared by Harvey E. Brown. New Jersey Zinc Co., New York, 1957. Cloth, 8¾ by 11 in., 100 pp. Price $3*

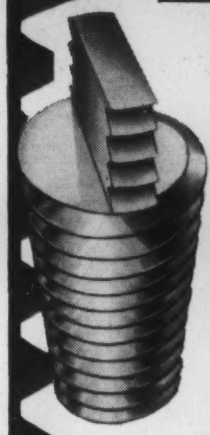
Although zinc oxide is used mainly as a white pigment in paints and as a filler in rubber compounds, recent research shows that it may have many other uses, especially in the electrical and electronic fields. It is the object of this book to point out the many new uses for zinc oxide by presenting its semiconductor, phosphor, electroluminescent, thermoluminescent, candoluminescent, ferrite, catalytic, photoconductivity, photovoltaic, photochemical and chemical properties in both text, tables and graphs.

A separate section outlines the use of zinc oxide in brake linings, adhesives, ceramics, lubricants, electrical insulations, phosphate coatings, paints, plastics and textiles.

Economics of American Industry: 3rd Edition. *E. B. Alderfer and H. E. Michl. McGraw-Hill Book Co., New York, 1957. Cloth, 6 by 9 in., 710 pp. Price $7*

Although the subject matter of this book is concerned primarily with the economics and structure of the major American industries, a number of chapters contain information on the nature and sources of raw materials, on competition in the aluminum industry, and on the use of synthetic fibers in textiles.

(Reports on p 232)



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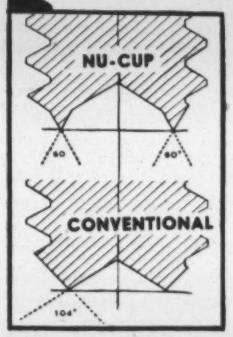

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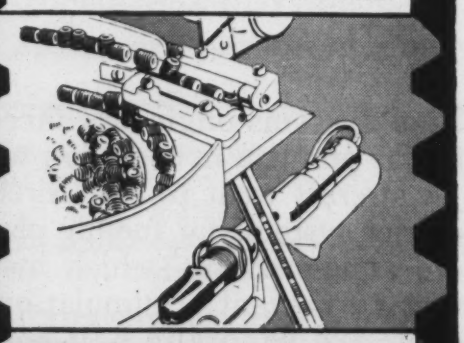

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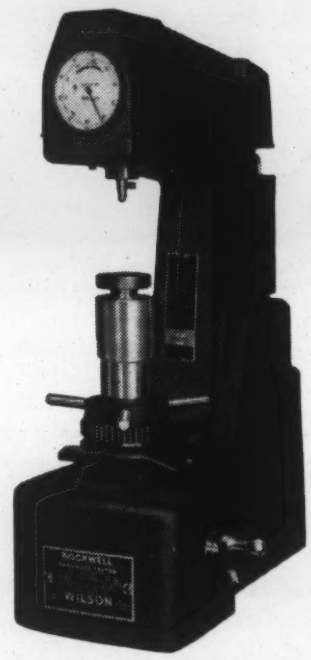

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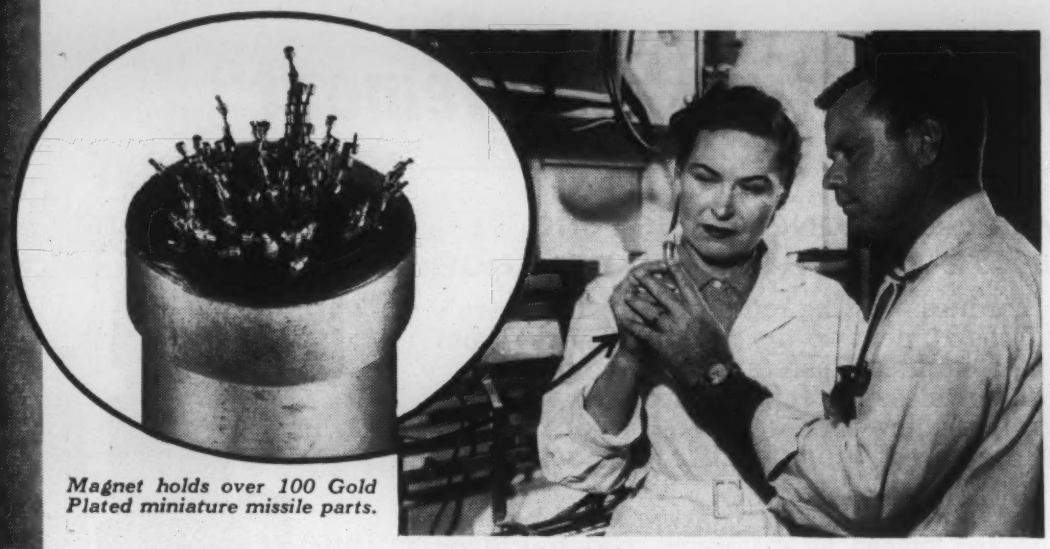

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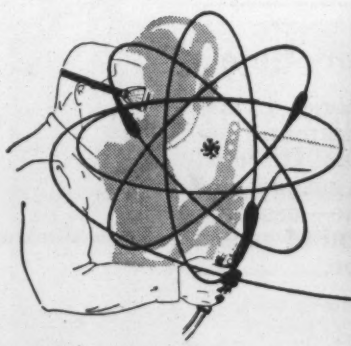

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TECHNICAL LITERATURE

Reports

Forging titanium THE INFLUENCE OF FORGING TEMPERATURE ON MECHANICAL PROPERTIES OF AL-V TITANIUM ALLOYS. *L. S. Croan and F. J. Rizzitano, Watertown Arsenal. Feb '57. 28 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. Price 75¢ (PB 131118)*

Information on a high temperature forging technique that is said to increase the toughness of aluminum-vanadium-titanium alloys by as much as 50% without significant effect on strength. Studies show that forging Ti-Al-V alloys above, rather than below, the beta transus temperature significantly increases V-notch Charpy impact energy.

Testing symbols NONDESTRUCTIVE TESTING SYMBOLS. *1958. 16 pp. Available from American Welding Society, 33 W. 39th St., New York 18, N. Y. Price $1 (AWS A2.2)*

Describes and illustrates symbols used on drawings to specify nondestructive tests for determining the soundness of materials. The symbols signify radiographic, magnetic particle, penetrant and ultrasonic tests.

Grain growth in alloys ABNORMAL GRAIN GROWTH IN NICKEL-BASE HEAT RESISTANT ALLOYS. *R. F. Decker, A. I. Rush, A. G. Dano and J. W. Freeman, University of Michigan. Dec '57. 70 pp. Available from National Advisory Committee for Aeronautics, 1512 H St. NW, Wash. 25, D. C. (TN 4082)*

Tests indicate that small reductions of essentially strain-free material are the basic cause of abnormal grain growth in air and vacuum melted Waspaloy, Inconel X-550 and Nimonic 80A alloys.

Materials for radiation MATERIALS FOR INSTRUMENTS IN RADIATION SERVICE. *1957. 16 pp. Available from Instrument Society of America, 313 6th Ave., Pittsburgh 22, Pa. Price 75¢ (RP 25.1)*

Analyzes the difficulties encountered in using plastics, metals, oils, glass and other materials in the presence of high energy radiation. Shows how to use these materials effectively under such extreme conditions.

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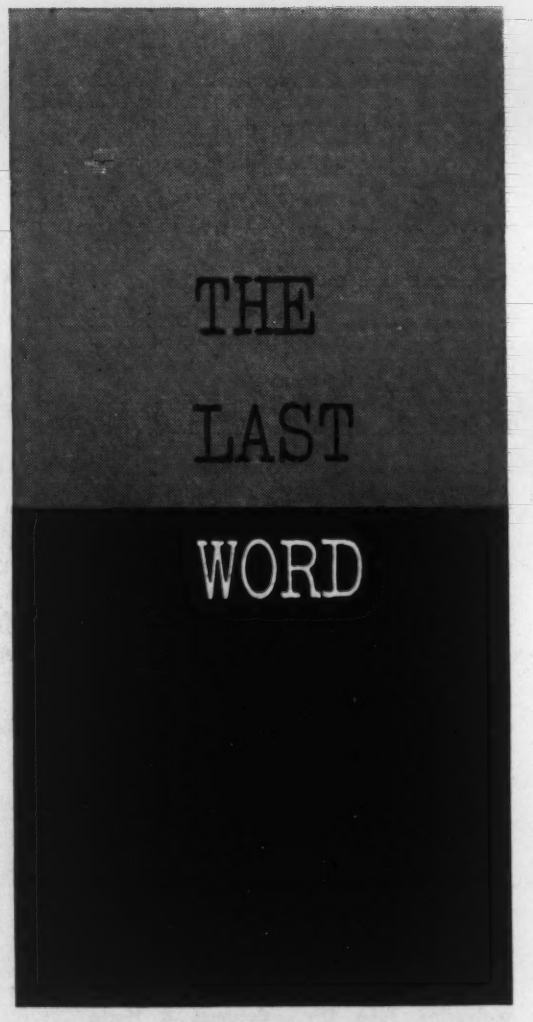


by ***H. R. Clauser,*** *Editor*

Getting to the Bottom of the Problem

At the recent annual meeting of the Northeastern Lumber Manufacturers' Assn. in New York City, the members spent one session on the problem of competitive materials entering some of wood's traditional markets. Included in the discussion was metal furniture. As it turned out, they were as close to the problem as they could possibly get. The chairs they were sitting on were made of aluminum.

Shark Repellent Nose Cones

As we go to press, no information has yet been released about the material used in the nose cone successfully recovered from the Jupiter rocket launched last month. However, we can speculate.

Knowing the temperatures attained with current high temperature test equipment, we can guess that during re-entry into the atmosphere, missiles may be subjected to temperatures somewhere in the range of 12,000 to 25,000 F. As far as we know, there are no materials presently available that will withstand continuously such extremely high temperatures. So it becomes a matter of using the material that will last the longest.

Surprisingly enough, according to M. W. Riley's article in this month's issue (p 100), plastics appear most promising because their decomposition rate is usually slower than that of metals. So it is not at all unlikely that the recovered nose cone was made of a reinforced plastic. A newspaper report that the nose cone had been treated with a shark repellent serves to bolster our speculation. Why? Because a shark expert told us that sharks like plastics better than metals.

Immaterialisms (from England)

▸ The Rolls-Royce people inform us in a current ad that before buying a Rolls-Royce we should, perhaps, consider our psychological make-up. They suggest that "people who feel diffident about driving a Rolls-Royce" can buy their lower-priced Bentley and thus not feel quite so conspicuous. The only difference between the two cars is the radiator. The radiator for the Bentley is simpler to produce and thus less costly. The resulting saving of $300 is passed on to the customer which brings the car's cost down to $13,250.

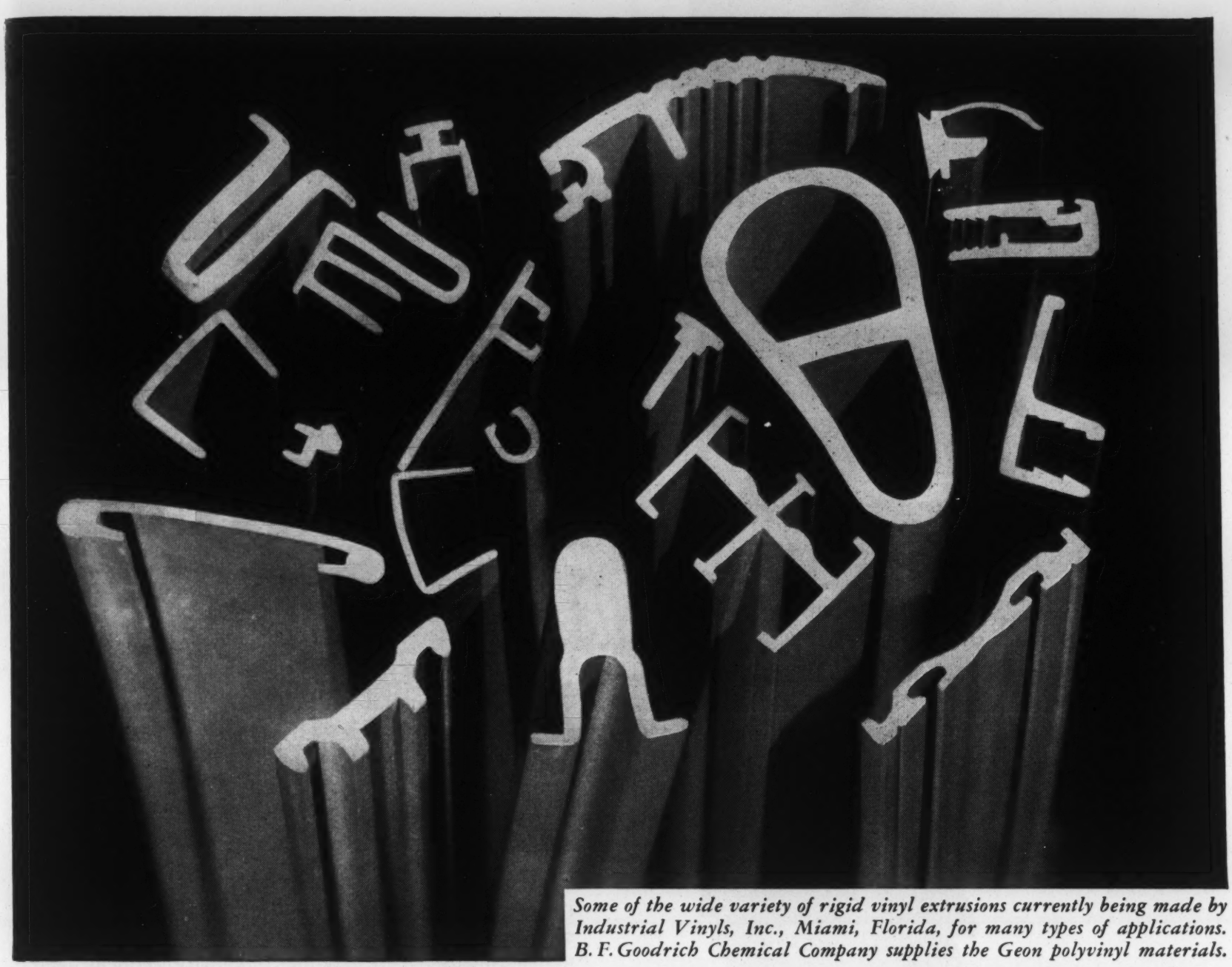
▸ In England tiddlywinks is a college sport. Even Prince Philip, the Duke of Edinburgh, sponsors a team. It is known as the Goons. Several months ago he apologized for not being able to join his team in a match with Cambridge. He said ". . . unfortunately, while practicing secretly I pulled an important muscle in the second or tiddly joint of my winking finger!"

▸ "Sir John Lubbock deserves the thanks of everybody interested in education for his persistent efforts to secure justice for science in elementary schools. We venture to say that everybody who has given much attention to the question agreed with the substance of his speech on Monday. Of course nobody wants to discourage the study of English grammar . . . It ought not, however, to have an advantage over science, as it has at present . . . An inspector quoted by Sir John Lubbock sneers at the notion of teaching children about 'cortical parenchymas and chlorophyle granules' . . . This is very cheap humor . . . A good teacher would find no difficulty in imparting much sound information without using a single hard word; and it ought to be remembered that the knowledge which most readily delights and stimulates children is knowledge relating to the world around them."

—*The Graphic,* London, Apr. 8, 1882

News about

B.F.Goodrich Chemical *raw materials*



Some of the wide variety of rigid vinyl extrusions currently being made by Industrial Vinyls, Inc., Miami, Florida, for many types of applications. B. F. Goodrich Chemical Company supplies the Geon polyvinyl materials.

Extrusions unlimited...in durable Geon rigid vinyl

A PROVEN performer in vinyl piping, Geon rigid vinyl compounds can be produced in a virtually unlimited number of other extruded shapes.

These unplasticized rigid compounds offer high structural and impact strength in addition to the basic advantages of all Geon polyvinyl materials. These include such properties as chemical inertness, resistance to most acids, alkalis, oils, and solvents, durability and abrasion resistance.

Geon 8700A and 8750 rigid compounds are meeting a steadily increasing number of structural and design requirements. Why not consider them in solving *your* particular problem. For booklet listing properties write Dept. LP-3, B.F.Goodrich Chemical Company, 3135 Euclid Ave., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ont.

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Aristoloy billets and bars in a wide range of A.I.S.I. analyses are available in carburizing and through-hardening grades. For assistance in selecting the best material for your job, call or write. A Copperweld Field Metallurgist will be glad to work with you.

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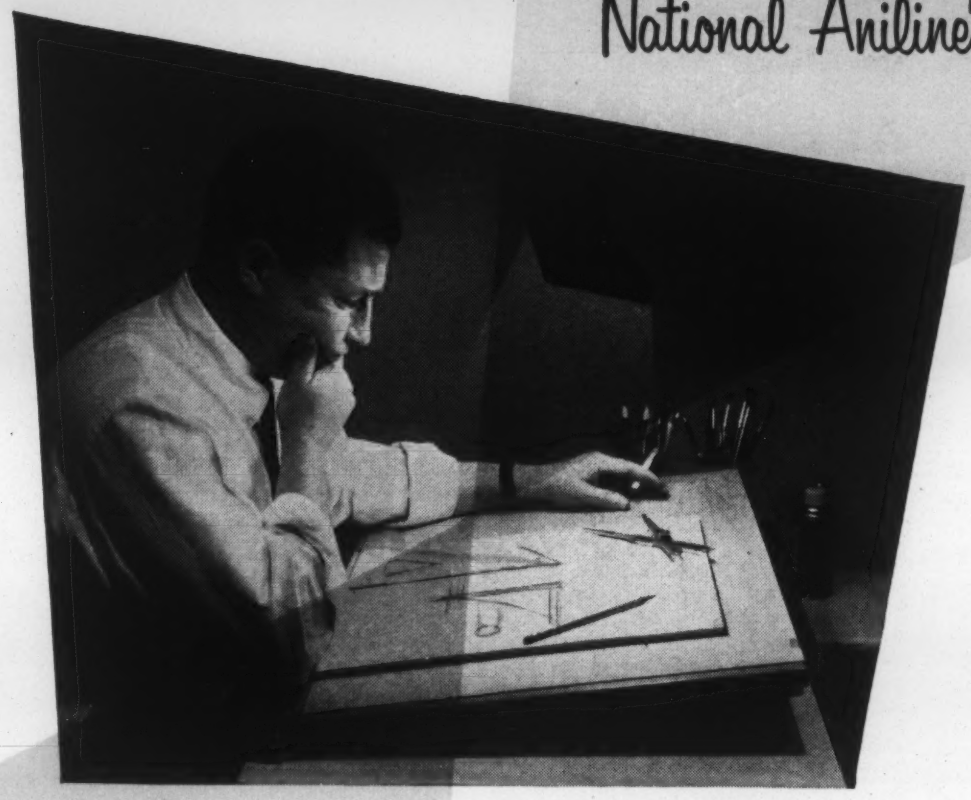

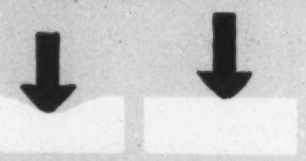

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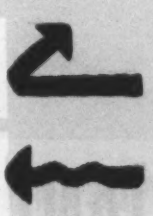

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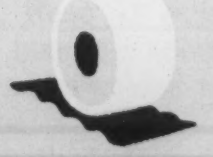

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Urethanes start closer to your finished product, eliminate many production steps. They can be molded to required shapes, foamed in place to fill voids. They adhere to other materials or encapsulate difficult shapes. They can be used in strong but lightweight sandwich construction, sprayed to adhere even to vertical or overhead surfaces. Slab stock can be sliced, die-cut, sewn, tacked or hog-ringed.

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"STRONG. FIRE-RESISTANT. CORROSION-RESISTANT. THAT'S WHY WE USE WEIRZIN® IN OUR STUD SYSTEMS!"

says G. A. Stevenson, vice president of Penn Metal Company, Inc., Parkersburg, W. Va., maker of PERMALOCK nailable metal stud systems.

"Broadly speaking, our choice of Weirzin electrolytically zinc-coated steel is based on two factors: performance in our products and performance in our production lines.

"With Weirzin, of course, our stud systems have the strength, rigidity and high degree of fire resistance inherent in steel. And because Weirzin's zinc coating is completely integrated with the steel, we have the added assurance of a corrosion-free life for our systems.

"In our production lines, Weirzin goes smoothly through every operation—no flaking or peeling regardless of the severity of the fabrication stresses.

"Briefly, we feel that Weirzin has helped us to produce a quality product that gives our customers solid value at low cost."

Strong! Highly resistant to fire! Highly resistant to corrosion! Easy to fabricate! That's Weirzin electrolytically zinc-coated steel. For more information on Weirzin send for free booklet. Write Weirton Steel Company, Dept. E-17, Weirton, West Virginia.

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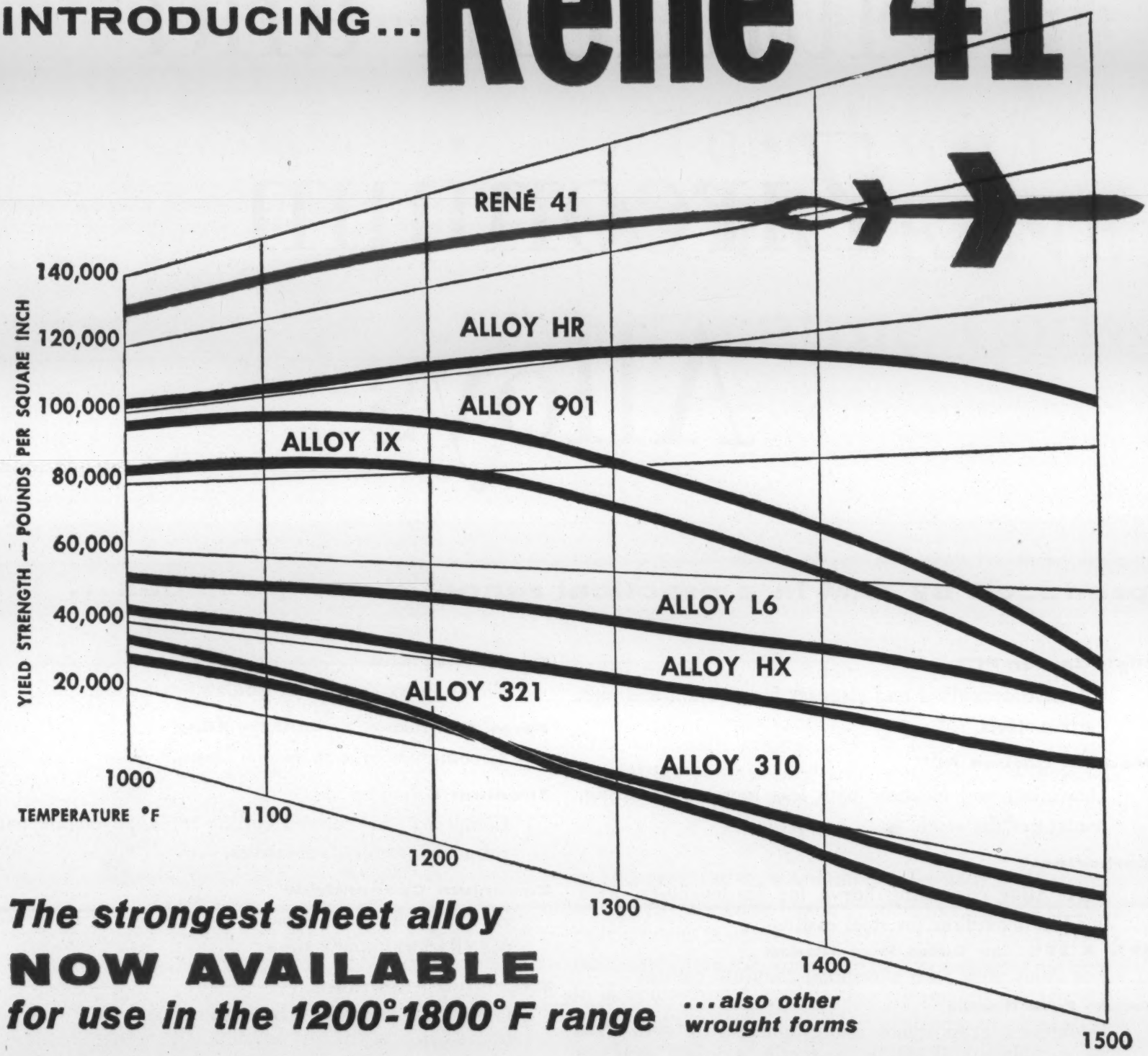
INTRODUCING... René 41



The strongest sheet alloy

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for use in the 1200°-1800° F range

...also other wrought forms

The chart speaks for itself. No high-temperature sheet material in use today has the yield strength of René 41. And yield strength is just part of the story. This nickel-base, vacuum-melted alloy has definite superiority in tensile strength... oxidation resistance... stress rupture life... ductility... and other desirable properties.

In workability too, René 41 excells. It's easily formable by drawing, bending, spinning and other forming methods — can be welded to itself, similar or dissimilar materials.

René 41 is readily available from Cannon-Muskegon in sheet, bar stock and wire forms. Sheets may be obtained "as rolled" or polished... sizes up to 48 x 120 in.... thicknesses down to .010 of an inch. For complete details, mail the coupon below.

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Effective deoxidizer and cleanser for medium and high carbon steels.

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Deoxidizer and cleanser with less increase in carbon content of the steel.

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FCT Alloy containing boron for hardenability. Also used as deoxidizer for steel castings.

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For Alloy steel with a residual titanium content.

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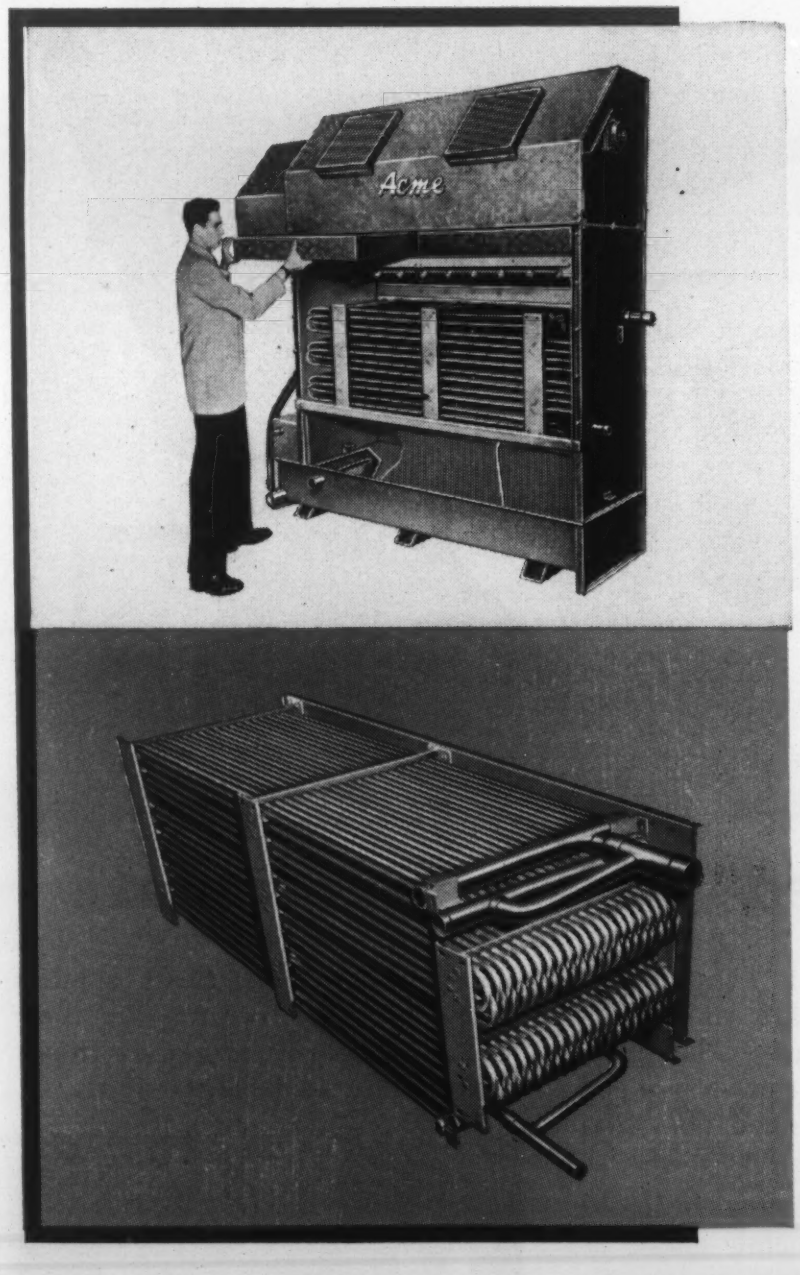
BEAT HEAT WITH AN *Acme* FLOW-MIZER® EVAPORATIVE CONDENSER

Tubed with WOLVERINE Serpentine Coils



Proud indeed of the efficiency and service it builds into its air conditioning and refrigeration equipment is Acme Industries, Inc., of Jackson, Michigan.

Equally proud of the recognition won by Acme since its founding in 1919 is Wolverine Tube. Over the years Wolverine has supplied Acme with mile after mile of gleaming, copper refrigeration tube—such as that illustrated at left in the Acme Flow Mizer Evaporative Condenser.

This nationally-known unit is widely used in both general air conditioning and refrigeration and in specialized industrial applications such as the cooling of plating solutions, chemicals, oils and other fluids.

In this unit, the tube bundle is fabricated by Wolverine into serpentine coils—each of considerable length. Thus, because of its fabrication facilities and know-how, Wolverine helps Acme obtain maximum condensing efficiency in a minimum of space. Also eliminated are the shipping, handling and assembly problems encountered in working with extremely long length tubing.

This is but another example of how Wolverine Tubemanship is serving American Industry. If your company uses tubing why not follow Acme's example—specify the products of Wolverine Tube. You'll find the complete story in our new book "Wolverine Serves the Refrigeration Industry". Write for your copy—TODAY!

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NEW WAY TO UPGRADE YOUR PRODUCTS: VINYL COATINGS

Pleasant-to-touch, glare-reducing dashboard finished with a vinyl dispersion that *creates its own patterns.*

For "leather-like" coverings for metal desk, file cabinets, and office appointments . . .

For stamped, light-metal luggage; instrument cases; office-machine housings . . .

Thin, leathery, "textured" finishes for metal

Something new in metal finishing: leather-like, warm-to-the-touch finishes that heat-cure to a textured finish. It's actually "texture in paint!" The base material: abrasion-resistant vinyl (of hard-wearing floor-tile fame) formulated as a dispersion for spray or dip coating. A single coat provides the complete finish. You can specify any shade or tone of color.

Short heat-cure at moderate temperatures adheres the vinyl permanently to the metal. These vinyl-dispersion finishes are so flexible, adhere so tenaciously, that pre-finished sheet metal can be stamped to shape without need for final finishing.

Write for sources of vinyl in liquid form for coating metal, glass, or wood. Get a head start on investigating the profitable ways to use these new, textured, leathery finishes. Write today!

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Monsanto manufactures a wide variety of plasticizers and Opalon® resins for formulators of these high-quality vinyl dispersions.

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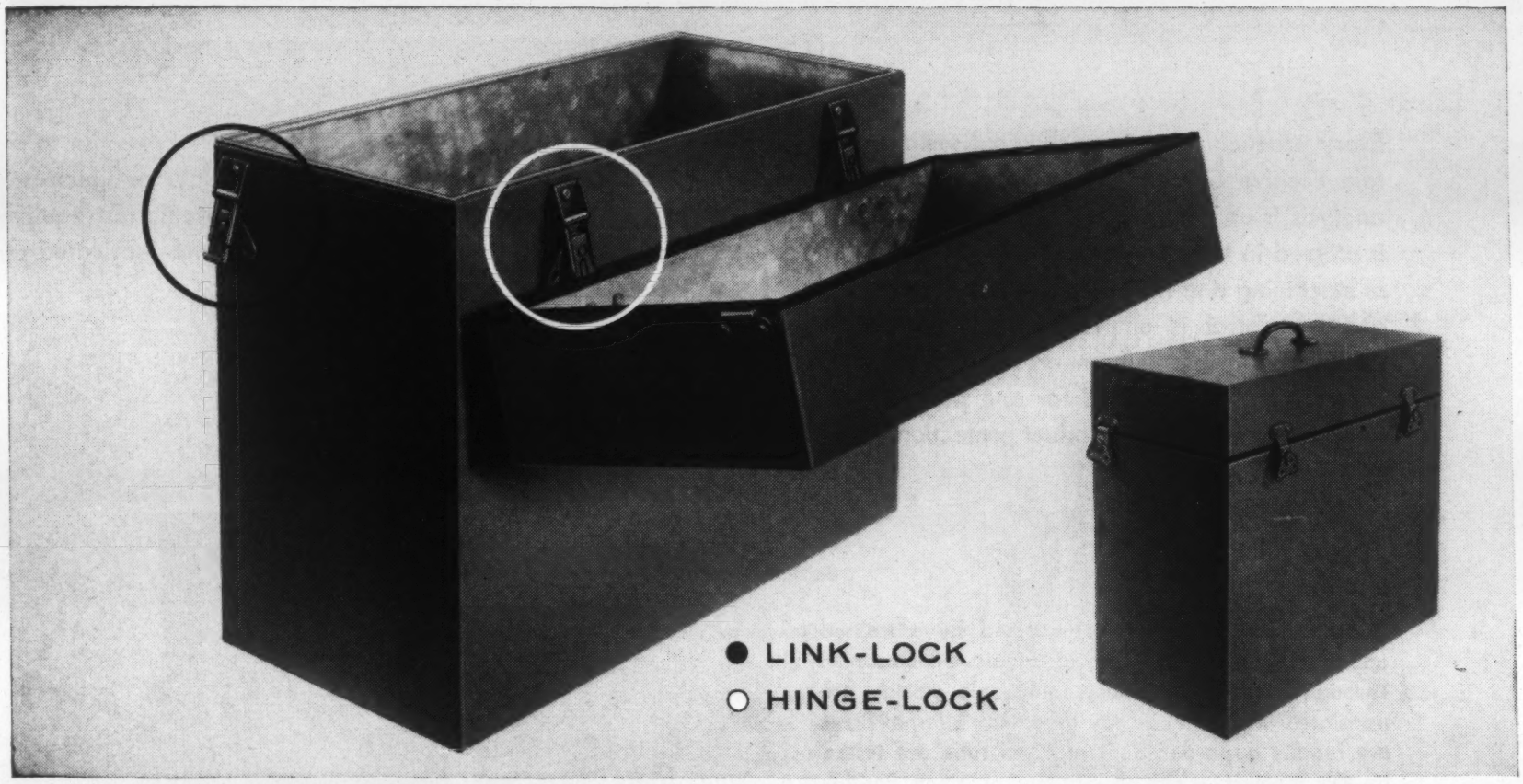
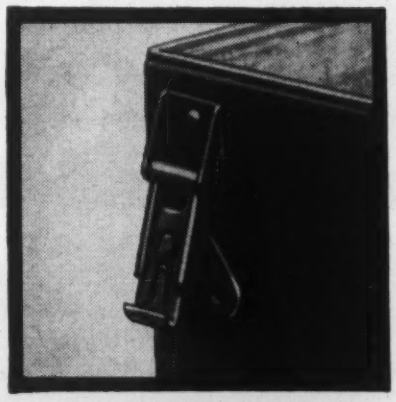
Now

An all-around pressure-tight seal for hinged-cover transit cases with

LINK-LOCK and HINGE-LOCK





No. 3 LINK-LOCK

No. 3 HINGE-LOCK

Two HINGE-LOCK and two LINK-LOCK Fasteners provide all-around sealing pressure on this container manufactured for the U.S. Navy by the Bonded Structures Division, Swedlow Plastics Company.

The new Simmons HINGE-LOCK, used in combination with LINK-LOCK, provides an even, pressure-tight seal on equipment containers and transit cases with hinged covers. A half-turn applies pressure to both types of fasteners. When pressure is released HINGE-LOCK becomes a free-operating hinge, and LINK-LOCK disengages to permit opening.

Originally developed by Simmons Fastener Corp. for the Engineering Department of Swedlow Plastics Company, Bonded Structures Division, HINGE-LOCK is similar in principle and appearance to LINK-LOCK. Both are available in light and medium duty sizes as matched hardware. LINK-LOCK is also available in a higher-capacity, heavy-duty size.

SEND TODAY for complete data, including dimensions, capacities. Engineering service is available... Outline your requirements. Samples on request.

See our 8 page catalog in Sweet's 1958 Product Design File

SIMMONS FASTENER CORPORATION 1759 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • LINK-LOCK • HINGE-LOCK • ROTO-LOCK • DUAL-LOCK

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ELECTRONIC and ULTRASONIC quality control of MUELLER rod, tube, fabricated parts and

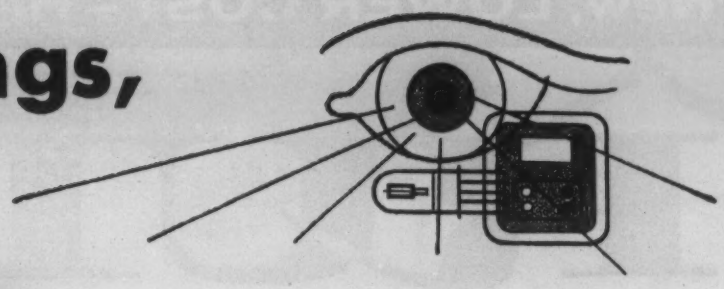
Every practical electro-mechanical testing device available to industry today is used by the Mueller Brass Co. to maintain Positive Quality Control during each manufacturing operation. From the first stages of alloying, spectroscopic analysis is used to maintain exact alloy composition so that they are precisely as specified. Ultrasonic test equipment is utilized in the non-destructive testing of extruded brass and bronze rod, copper tube, forgings and fabricated parts. In machining and finishing operations, statistical quality control is employed to eliminate the effect of possible human error. These quality controls are all designed for one purpose . . . to give you complete "product protection."

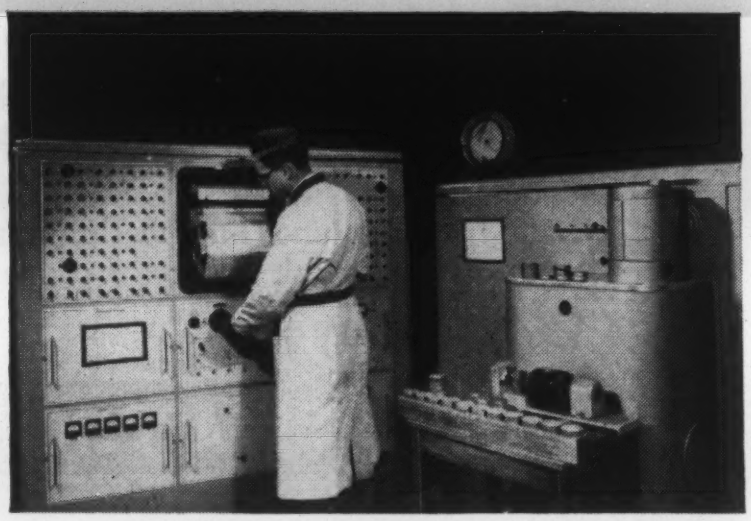
•

Copper base alloy rod is examined by a trained operator with the aid of an ultrasonic reflectoscope. Through electronic circuitry, ultrasonic echoes are translated on a cathode ray tube. Any internal flaws are readily apparent. Both rod and tube are tested by this method, which is just one of many Positive Quality Control checks used by the Mueller Brass Co.

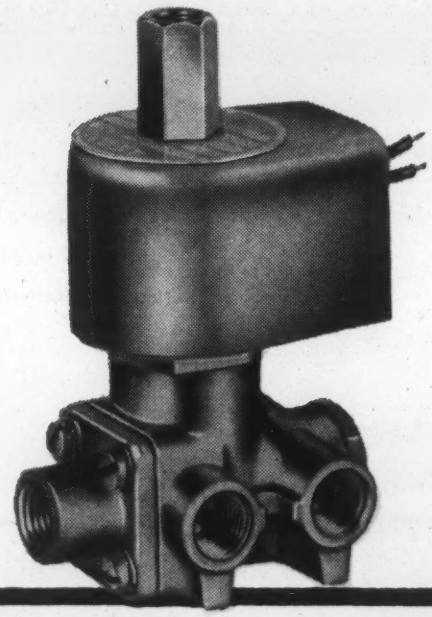
Through ultrasonics, the immerscope (Left) locates internal defects, and has exceptional versatility for examining intricately shaped parts, such as the forging being checked in this photo. When testing, a transducer, located at the bottom end of the search tube, is electronically actuated to produce from 2.2 to 25 million cycles per second. Ultrasonic echoes are reflected back to the transducer from the material, indicating any defects that may be present. Limits may be pre-established and the sound findings are visually recorded on the cathode tube. This is another instance of Positive Quality Control in action.

TESTING helps insure positive BRASS CO. forgings, assemblies . . .

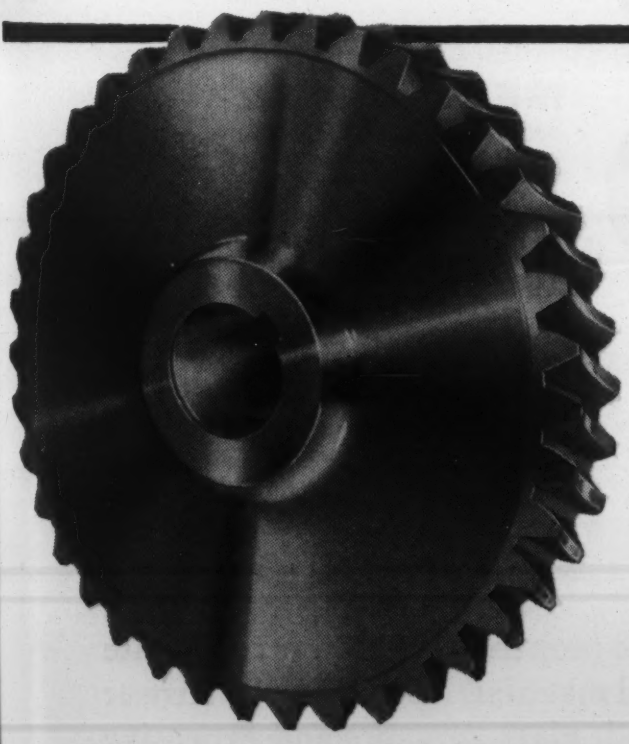




The direct reading spectrometer (Left) makes it possible to accurately analyze an alloy for chemical composition within 90 seconds while the metal is in the molten stage. A sample specimen is poured, cooled and sent to the laboratory, where it is placed in the spectrometer. Through the diffraction gratings in the machine, the "spectrum" analysis of the alloy records its exact chemical composition. With this equipment, alloy specifications are matched exactly, thus insuring a better finished product through Positive Quality Control.

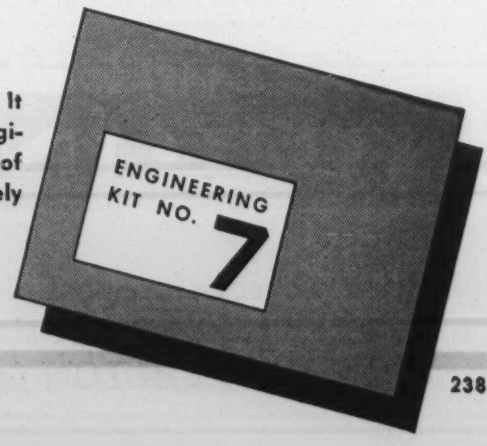


THIS MIDGET 4-WAY SOLENOID VALVE (Right) is one of a complete line designed and manufactured by the Automatic Switch Co. (ASCO) of Florham Park, New Jersey. Valves of this type are used for controlling small double acting cylinders which operate valves, dampers and many types of automatically controlled equipment. One of the most important components in these valves is the non-porous brass body forged by the Mueller Brass Co. who also perform all the major machining operations so that the body is ready for use upon delivery. The forged brass body insures freedom from porosity and reduces possibility of corrosion. The Mueller Brass Co. Positive Quality Control program insures ASCO complete "product protection". . . and eliminates chance of "in-service" failures.



THIS LARGE 18" FORGED GEAR, along with two others of the same type, is used in a steam turbine installed in a power generation facility of the Wisconsin Electric Power Company, at Port Washington, Wisconsin. The gear was forged in open dies by the Mueller Brass Co. from tough, long-wearing 603 alloy. The gear operates at 25-30 RPM and is turned by the turbine, which has a capacity of 80,000 kilowatts. Strength and dependability are of utmost importance in applications like this, and in such cases Positive Quality Control insures peak performance.

Write for your engineering kit no. 7. It contains complete laboratory and engineering data plus typical examples of Mueller Brass Co. products used in widely diversified applications.



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MUELLER BRASS CO. PORT HURON 21, MICHIGAN

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DESIGN ENGINEERING DATA*

A New, LOWER COST– High Efficiency Fluorocarbon

RULON®

- newest, *most versatile* "SUPER TEFLON".
- *Lowest priced* of all comparable fluorocarbons.
- a modified TEFLON fluorocarbon enhanced by a superior blend of additives and reinforcing agents.
- an *accepted, tested* and *proven* TEFLON offspring with broader, more efficient and more economical applications.
- a dynamic Design and Engineering material: super performance with *improved* properties.

TESTED RULON PROPERTIES:

(as compared to TEFLON†)

■ SUPERIOR:

Wear Resistance
Hardness
Stiffness
Cold Flow
Deformation Under Load
Compressive Strength
Thermal Conductivity

■ SIMILAR:

Elongation
Impact Strength
Tensile Strength
Electrical Insulation

■ SAME:

Low Coefficient of Friction
Extreme Heat Resistance
Chemical Corrosion Resistance
Non-flammability
Outdoor Durability
Zero Water Absorption
Flexural Strength
Non-stick Properties

†DuPont's TFE Fluorocarbon Resin

(Write for actual values)

PROVEN RULON APPLICATIONS

ELECTRICAL

Relays, Potentiometers, Antennae, Terminals and Connectors, Bushings and Washers.

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Bearings for Acids and Dyes; Non-toxic Bearings for Food and Liquid Processing; Oil-free Bearings; Freon-resistant Seals; Refrigeration Seals.

MECHANICAL

Piston Rings, Torque Control Bushings, Textile Bearings, Rotary Seals, Cam Followers, Pump Bearings, Cups and Seals, Thrust Washers, Gaskets and Packings, Valve Seats.

(Write for actual applications)

RULON®

a "super-TEFLON" whose properties and lower cost create applications never before possible for a designed-in and engineered material. *RULON* is the answer to a low-cost replacement for sintered metals, ball bearings, wood, glass, ceramics and expensive fluorocarbons. Select RULON *for more and longer performance at a lower cost.*

Write for further information and prices.

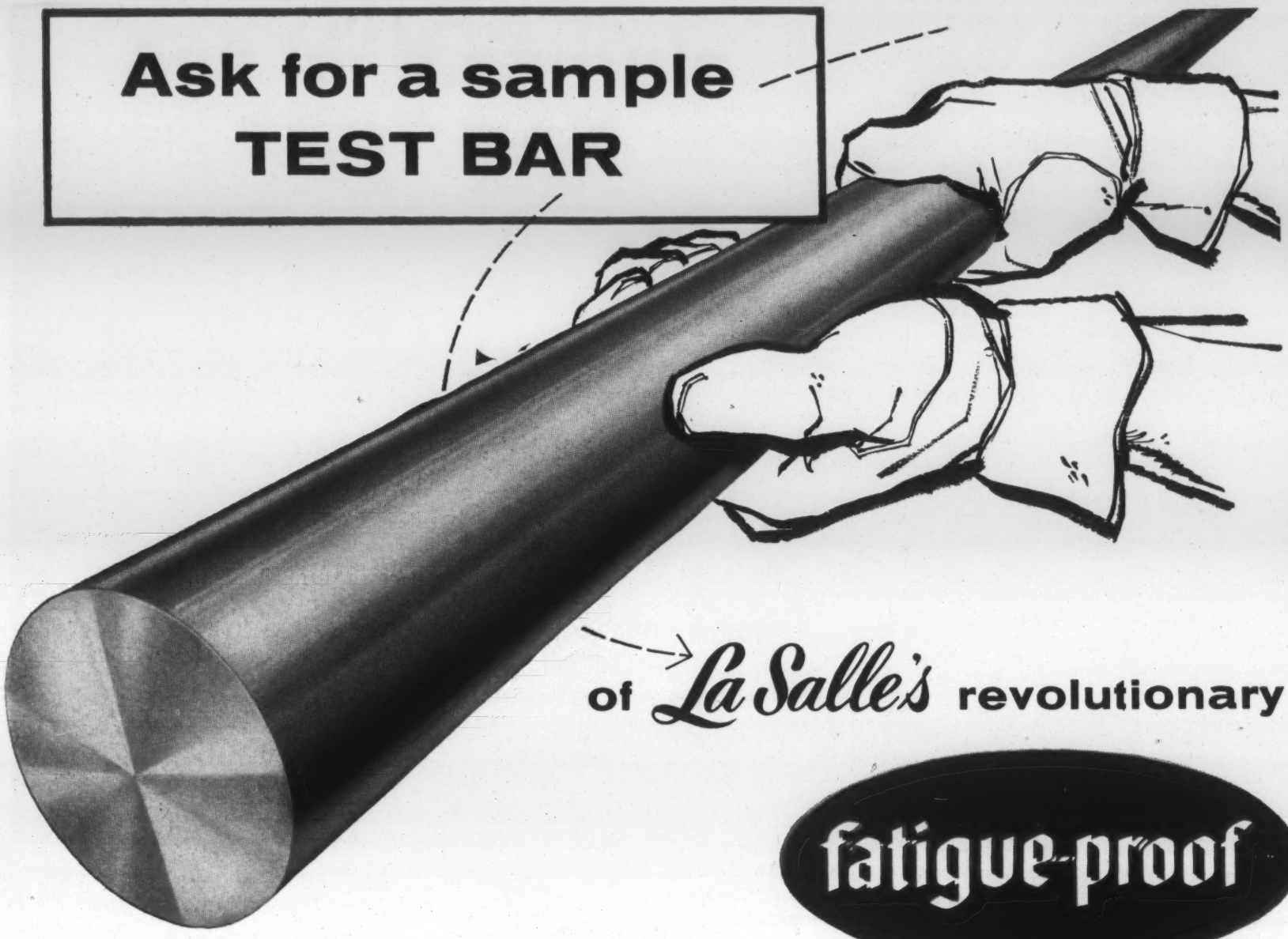
*plastics division:

Dixon Corporation

BRISTOL, RHODE ISLAND

Established

Ask for a sample TEST BAR



of *La Salle's* revolutionary

fatigue-proof steel

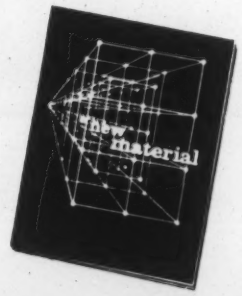
The steel bar that has high strength WITHOUT HEAT TREATING

Yes, La Salle invites you to test a sample bar of the remarkable new FATIGUE-PROOF. This amazing new material is its own best recommendation . . . as proven by the many original equipment manufacturers who have already tested (and are using) FATIGUE-PROOF.

If you are making parts requiring strengths in the tensile range of 140,000 to 150,000 psi, and want to eliminate the expense or problems of heat treating . . . if you want to save production costs with a bar that machines faster (25% faster than annealed alloys—50% to 100% faster than heat treated alloys) and gives you a beautiful finish, too . . . if you want to improve the quality of your product while saving money, send us a blueprint, drop us a note giving application details, or better yet . . . pick up your telephone and call a La Salle sales engineer (REgent 4-7800, Chicago, Illinois).

FREE

Get your copy of "a new material," a 24-page booklet which gives detailed information on La Salle "FATIGUE-PROOF"® steel bars.



La Salle **STEEL CO.**

1418 150th STREET • HAMMOND, INDIANA

Manufacturers of America's Most Complete Line of Quality Cold-Finished Steel Bars

Please send me your "FATIGUE-PROOF" Bulletin.

Name_____

Title_____

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City_____ Zone____ State_____

For more information, circle No. 523

For more information, turn to Reader Service card, circle No. 462

Urethane rubber mallet head is so tough it can drive spikes through 2 x 4 without damage, yet so resilient a similar blow will not mar a polished table top.

New Urethane Material Combines Bounce of Rubber With Toughness of Metal

Resistance to high and low temperatures, common solvents, grease and oil make urethane rubber a natural choice for diaphragms, reservoirs and pump parts for industrial equipment.

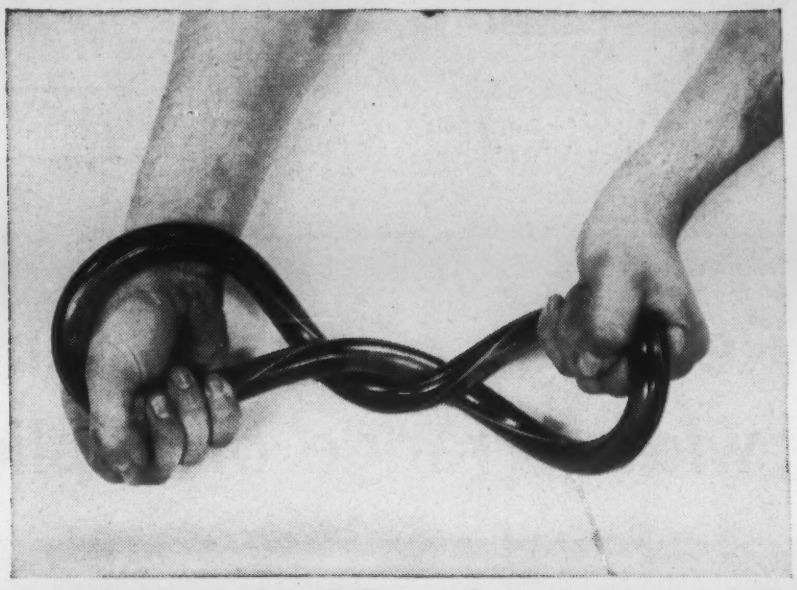
. . . Gives Up To 10 Times The Wearability of Ordinary Rubber.

An entirely new kind of rubber, classed as a chemical elastomer, is being evaluated as the first elastic material that can qualify as a replacement for metals and plastics in industrial uses where a high degree of hardness must be combined with good flex fatigue resistance, exceptional toughness and wearing abilities.

Urethane rubber, extensively field tested in European automotive and original equipment uses, is now being commercially developed in this country by Mobay, a major supplier of urethane chemicals. In commercial application tests, the new material exhibits such a broad range of desirable engineering properties, plus unusual versatility in the way such properties as hardness and elasticity can be combined, that product engineers in many basic industries see in it the key to radical design changes in the industrial equipment field.

In one functional area, particularly, the triumph of urethane rubber over conventional rubber materials seems complete. In direct contrast to natural and other synthetic rubbers, the tear strength and abrasion resistance of the urethane product increases in almost direct proportion to the hardness

In addition to exceptional strength and abrasion resistance, the ease of casting urethane rubber in parts with difficult undercuts, slots, inserts and threads puts this material in the "work horse" category for designers and engineers.



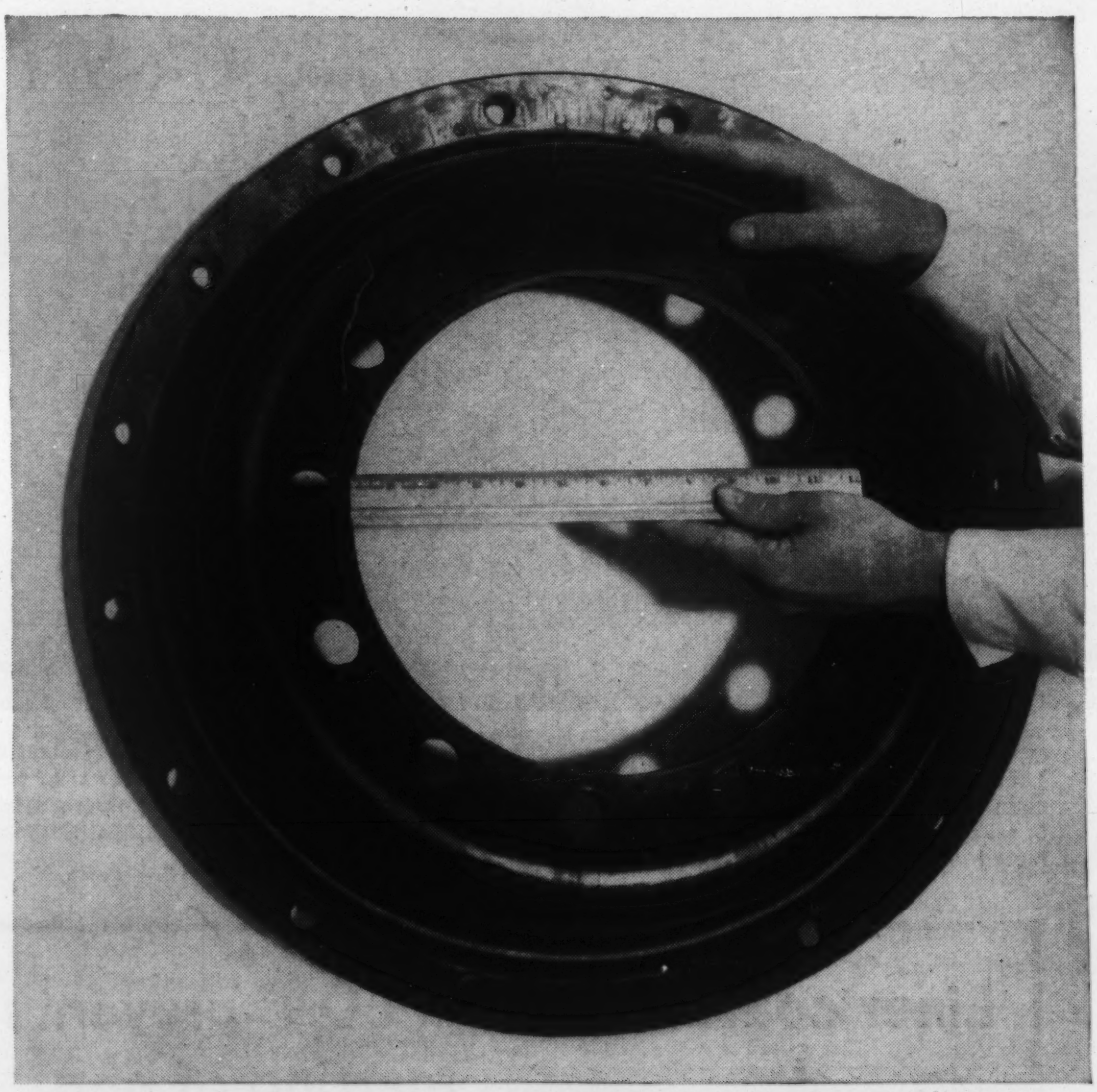
A high degree of flexibility and extraordinary tensile strength are among properties which may be combined for drive belts. Low abrasion loss, lower noise level and high coefficient of friction are additional advantages.

factor. In controlled laboratory tests, urethane rubber with a hardness value of 78-83 Durometer (Shore A Scale) was found to provide from three to ten times the wear resistance of other rubber materials in the same category.

In ordinary rubber, toughness is increased by blending in fillers which deaden elasticity, and by use of fibers which increase cost and reduce working properties. In contrast, the toughness of urethane rubber is achieved by modifying the molecular structure of the material itself which imparts an inherent stability to the end-product and makes precise quality control possible.

The superiority of urethane rubber over other types of rubber is unmistakable . . . in rebound elasticity, high and low temperature strength, elongation, resistance to solvents, ozone, acids and oxygen; in electrical properties and dielectric constant . . . and in other properties of interest in specialized manufacture.

Urethane rubber can be cast or machined to meet specifications for almost any configuration or contour, for such uses as oscillating bearing surfaces, automotive suspension systems, ball-joint assemblies, gears, grommets, vibration dampening devices, tools and industrial truck tires. Its exceptional strength and toughness make it an alternate choice for metals, in many cases, as well as an improvement over molded nylon and other rubber materials.



Huge flanged coupling for ship's drive shaft, cast of urethane rubber in one piece without reinforcement, will outwear ordinary materials many times.

For further information, technical assistance and sources of supply for urethane rubber, write to:

MOBAY
CHEMICAL COMPANY
Dept. MD-3 • Pittsburgh 34, Pa.

MOBAY
First in Urethane Chemistry

For more information, turn to Reader Service card, circle No. 515

DU PONT
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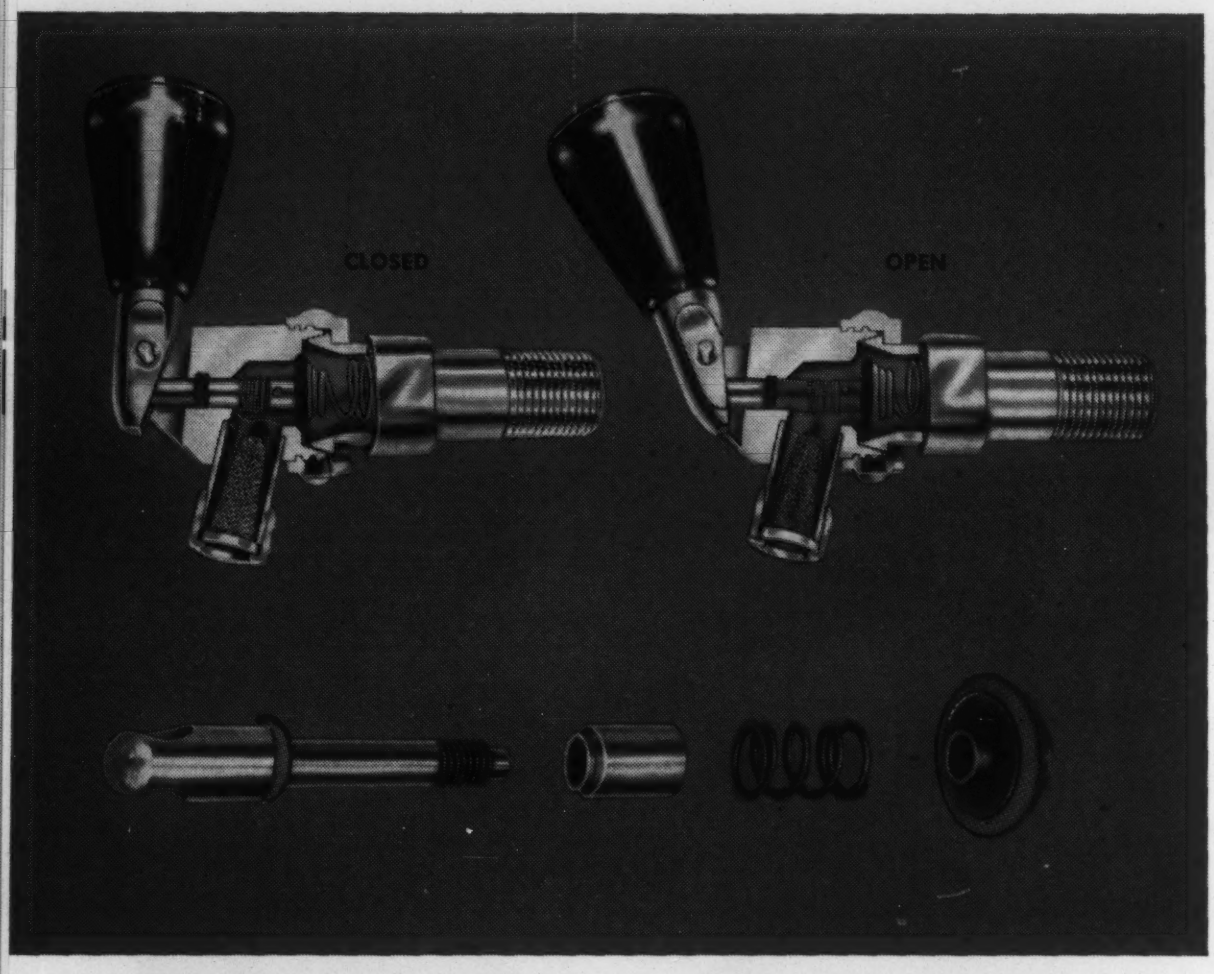
Better Things for Better Living ... through Chemistry
PRODUCT ENGINEERING NEWS
LATEST PROPERTY AND APPLICATION DATA ON
TEFLON® TFE-fluorocarbon resins

Redesign of valve stem to use O-rings of TEFLON® TFE-fluorocarbon resins widens range of applications of chemical faucet



NEW DESIGN, based on the properties of a TEFLON resin, makes this a truly all-around chemical faucet. Valve stem was redesigned to take new seals. The O-rings remain unaffected even when dispensing such highly corrosive liquids as rocket fuels. (Faucet by ECO Engineering Company, Newark, New Jersey; O-rings of TEFLON TFE-fluorocarbon resins by Halogen Insulator & Seal Corporation, Franklin Park, Illinois.)

The ECO chemical faucet had an inherently wide range of uses, because it was made of stainless steel. But certain limitations were imposed by failure of its seals in contact with various corrosives and solvents. A simple design change made it possible to use seals of a TEFLON TFE-fluorocarbon resin, one of the most chemically inert materials known.

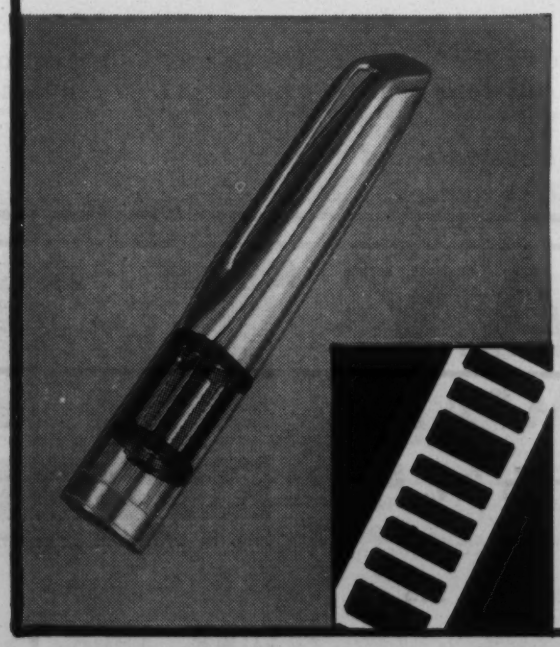
The stem was redesigned in such a way as to permit the small O-ring to be mounted without physical deformation by means of a shank sleeve. The larger O-ring is assembled into its groove by an adapter and is allowed to contract in place.

The gains were impressive. Even where highly resistive materials had undergone cracking, discoloration and failure—as in the handling of the rocket fuel hydrazine—TEFLON TFE-fluorocarbon resins showed no sign of change. They are unaffected by heat to 500°F. and do not embrittle even in liquid helium. Due to their extremely low-frictional surface, the seals slide easily . . . never stick. Tight, leak-proof closure is assured.

This is another example of the *right material* for the job . . . plus *good design.* Perhaps you can use a TEFLON resin to to get similar outstanding advantages. Learn what these advantages can be, and receive a technical report on the engineering properties of TEFLON resins by writing to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 23-6, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Ltd., P. O. Box 660, Montreal, Quebec.

Liner coated with TEFLON® TFE-fluorocarbon resins prevents marring of pen



Sections of stamped copper strip coated with a TEFLON TFE-fluorocarbon resin are used to line this fountain pen cap. The smooth, low-friction coating makes it easy to slip the cap onto the pen and prevents marring of the ends. The resin protects the spring against corrosion, and its anti-stick properties prevent adhesion of ink. (Made by Waterman Pen Co., Inc., Seymour, Connecticut.)

TEFLON®
is a registered trademark...

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE-fluorocarbon resins discussed herein. This registered trademark should not be used as an adjective to describe any product, nor should it be used in whole, or in part, as a trademark for a product of another concern.

C/R now offers you the advantages of reinforced TFE... designed, compounded and molded by a single source!

If your work involves sealing applications, you are probably familiar with "Teflon", Tetrafluoroethylene Resin. The extreme versatility of its chemical, thermal and mechanical properties are unmatched by any other material on the market.

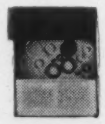
You may not be, however, fully aware of the degree to which these properties can be distinctly improved by the use of reinforcing inorganic additives. For example, "Teflon" can be blended with inorganics to increase:

- **Resistance to deformation under load — by a factor of 10**
- **Resistance to wear by rotating shafts—by as much as 500 times**
- **Stiffness — by a factor of 4-5**
- **Thermal conductivity—by a factor of 5-10**
- **Compressive strength — by a factor of 3-4**
- **Hardness — by 10%**

It is also useful to know that Chicago Rawhide is one of the few fabricators which blends its own "Teflon" compounds, assuring constant quality in batch after batch and permitting compound formulations to be developed rapidly and accurately. Our new laboratory and production facilities are unexcelled – and these facilities are matched by our experience in molding synthetic parts to meet the most critical specifications.

C/R Sirvene welcomes the opportunity to cooperate with you in the design and production of "Teflon" and reinforced "Teflon" packings, bearings, gaskets, rings, or other parts.

If you are interested in "Teflon" write for your free copy of Sirvene Materials Bulletin CT-1.



*"Teflon" is a DuPont registered trademark

CHICAGO RAWHIDE MANUFACTURING COMPANY
1227 ELSTON AVENUE • CHICAGO 22, ILLINOIS
Offices in 55 principal cities. See your telephone book.
In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario. **Export Sales:** Geon International Corp., Great Neck, New York.
Other C/R Products: *C/R Shaft and End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears*

SIRVENE C/R DIVISION
CHICAGO RAWHIDE

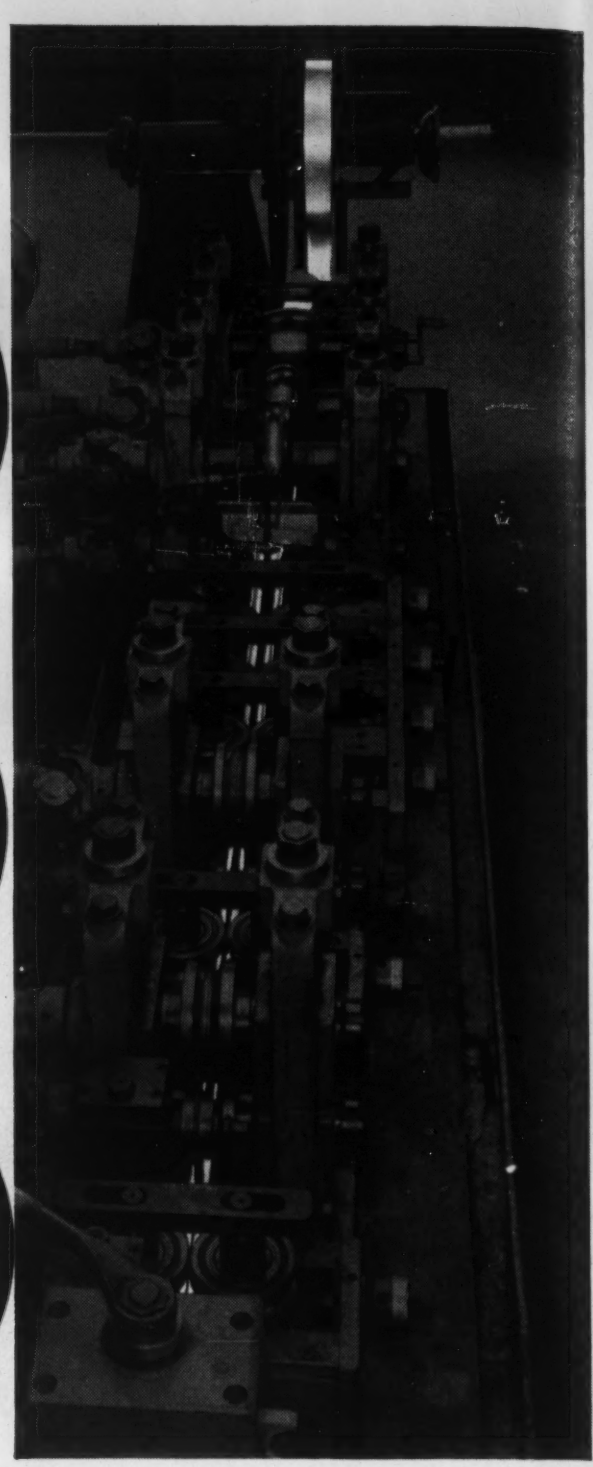
For more information, turn to Reader Service card, circle No. 542

STAINLESS

STEEL

PIPE &

TUBING

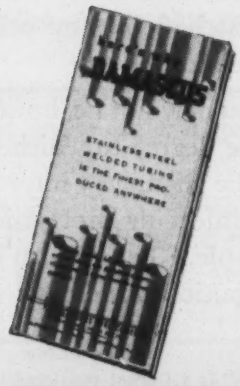


Warehouse Stocks Backed By Production Capacity

Damascus is a completely equipped, modern plant, able to offer stainless steel tubing in a wide range of standard A.I.S.I. analyses plus special alloy grades.

Prompt mill deliveries are possible from mill inventories, and large stocks of stainless strip on hand usually permit us to complete rush orders within a few days.

Supplementing our fast mill service are well-stocked warehouses of pipe and tubing conveniently located in major industrial areas. For prompt *local* service and immediate delivery of Damascus tubing, get in touch with your local Steel Service Center.



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AMERICAN STEEL WAREHOUSE ASS'N.

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

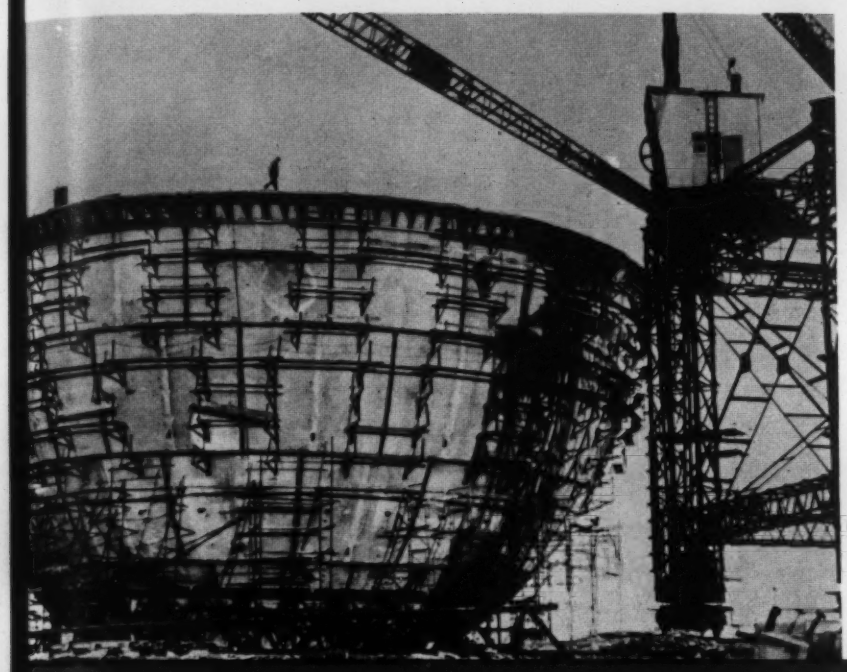
FORMED STEEL TUBE INSTITUTE

For more information, turn to Reader Service card, circle No. 437

For more information, circle No. 536

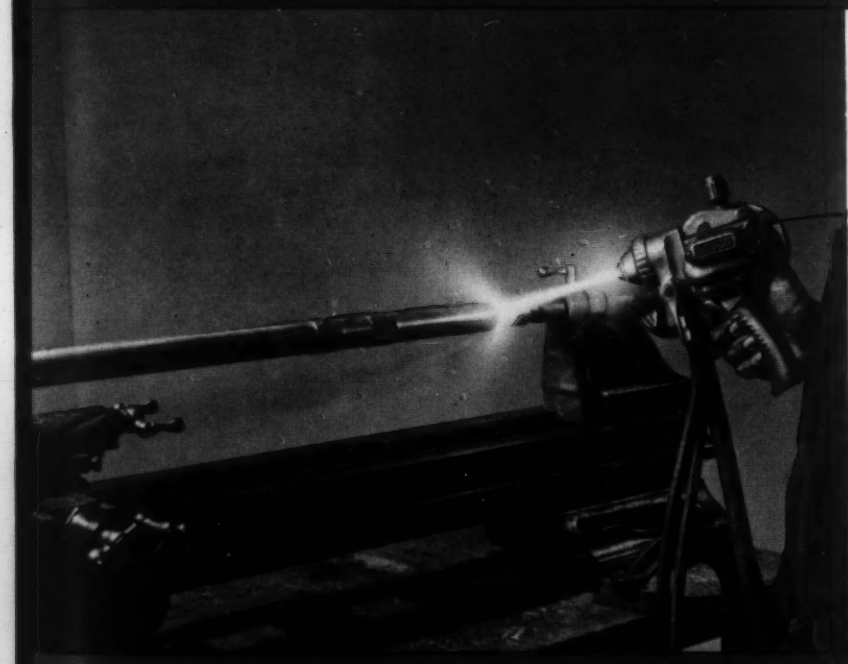
Metco Metallizing News

Developments in sprayed metal and ceramic coatings



Protection against atmospheric corrosion

This 135-foot diameter sphere, being erected in Scotland for the United Kingdom Atomic Energy Authority, will house an atomic reactor. All steel sections were metallized with zinc prior to erection. Weldments were touched up after erection. Coatings like this provide 20-25 year protection without further attention.



Hard facing aluminum

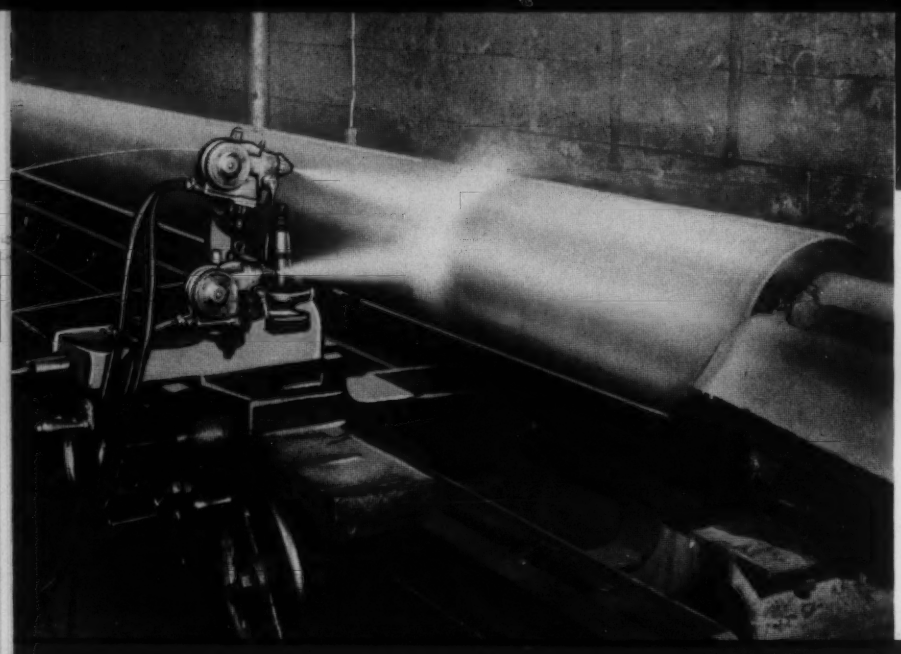
Aluminum torque tubes, used to control aircraft trim tabs, are hard surfaced by metallizing with stainless steel on bearing sections; combine the advantages of the lightweight aluminum with the wearability of steel.

Heat resistance

Graphite crucible shown being coated with ThermoSpray Powder 201 (zirconia, melting point 4600°F.) which maintains the absolute purity of the melt by preventing pick-up of carbon particles. The Metco Type-P ThermoSpray Gun is being used with extension.

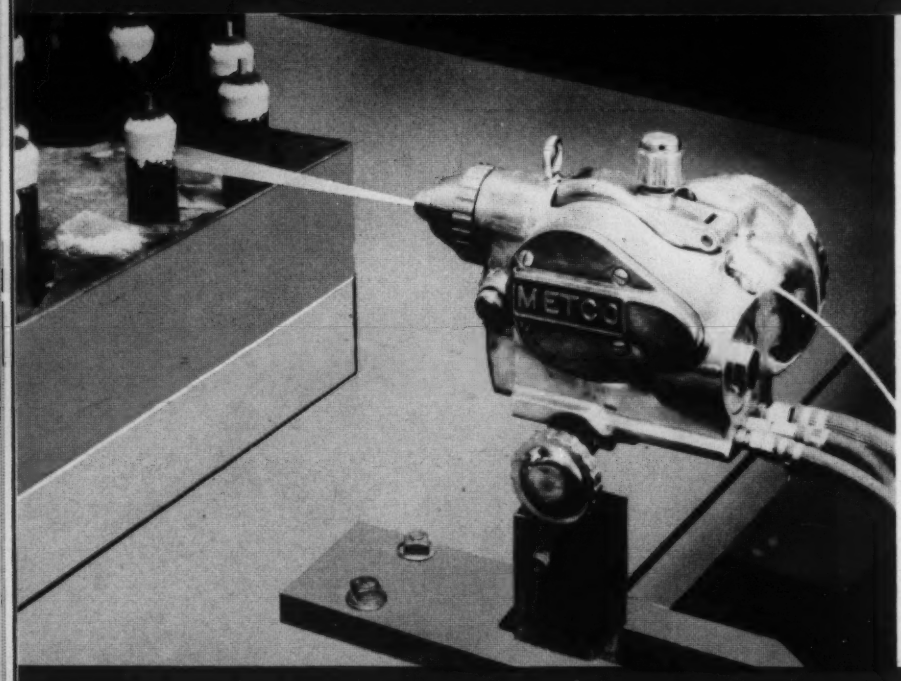
MORE

Metallizing News



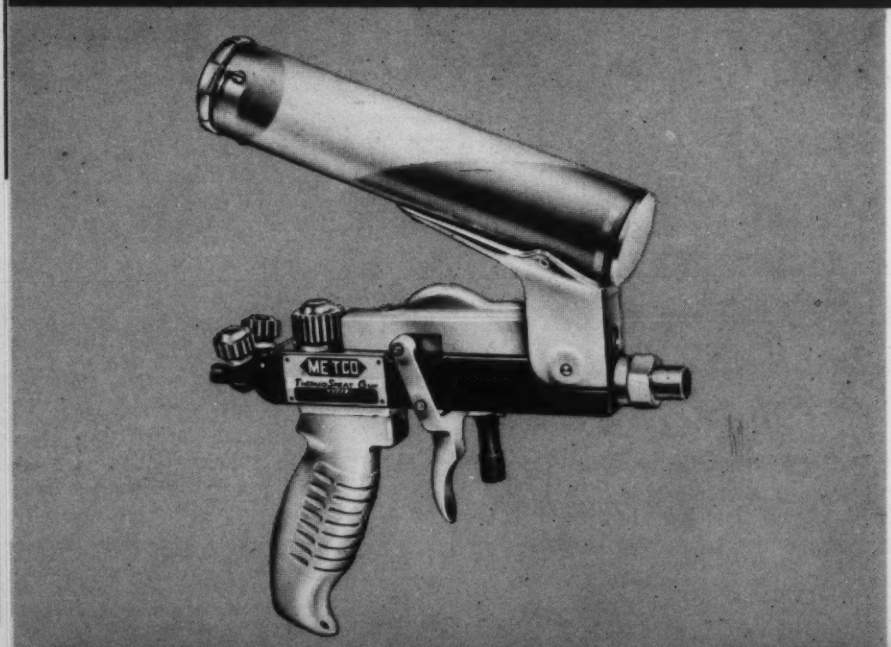
Stainless steel cladding

Hydraulic ram being metallized by two Type Y Metallizing Machines. This is not a repair job. New rams 27′ long are made from heavy steel tubing and are then coated with hard, corrosion resistant Metcoloy #2.



Electrical contacts

Metallized copper, on the ends of these ceramic-base resistors, provides contact to which leads may be soldered. Other electrical applications include metallizing copper on ceramic insulators to provide ground sleeves, reduce corona effect; sprayed aluminum to provide electrically reflective surface on fiberglass radar antennaes; wide range of shielding applications.



Powder spraying... ceramics—metals

The METCO Type-P ThermoSpray Gun incorporates an entirely new principle which permits the spraying of high melting point materials, such as nickel-chromium-boron self-fluxing alloys for hard facing and corrosion resistance, and ceramics such as alumina and zirconia for heat insulation and abrasion resistance. These materials are sprayed many times faster than with any previously known powder gun, with deposit efficiencies above 90%.

Sprayed coatings of metals and ceramics provide the design engineer with wide new ranges of mechanical and physical characteristics with which to work. These may be applied to particular areas of a product with consequent increase in flexibility of design. If you would like additional information, write for Bulletin 125—"Basic Engineering Data on Wire and Powder Sprayed Coatings of Metals and Ceramics," Bulletin 124—"ThermoSpray Ceramic Coatings," Bulletin 126—"High Speed Low Cost Hard Facing."

METALLIZING ENGINEERING CO., INC.

[illegible] Prospect Ave., Westbury, Long Island, New York

[illegible] EQUIPMENT CO., LTD., Clubbon near Wishaw, England

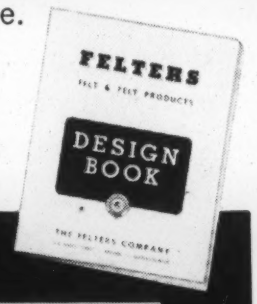
SPECIAL FELT TREATMENTS Increase Life, Improve Properties for Seals, Filtering and Cushioning

Never before has FELT been able to provide such a wide range of properties — for such applications as seals, filtering and cushioning! And Felters is continually experimenting with many combinations to provide designers with more and more versatility in felt, including use of the newest synthetics and plastics.

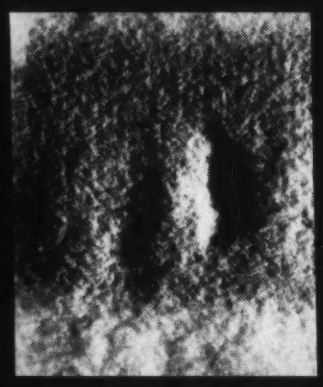
What do you want FELT to do?
Felters has pioneered in producing felts which have unusual properties for special applications.

Let Felters help you make felt do more jobs, more efficiently — with special treated or standard Cut Parts. Specific technical service is available from any Felters office.

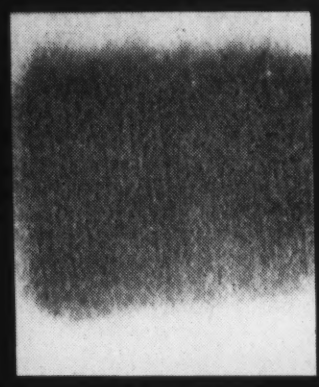
Send for Design Book . . .
for a complete digest of basic data on felt properties and uses.



Felters' Nylon-treated all wool Felt provides extra wear, superior resistance to scuffing, abrasion and friction. Extra strength without increased density. Each fiber encased in protective sheath of nylon. Porosity and resistance of felt unaffected. Wyzenbeck Wear Test of 6,000 strokes on Untreated versus Nylon Resin Treated Swatches demonstrates the difference.



Untreated



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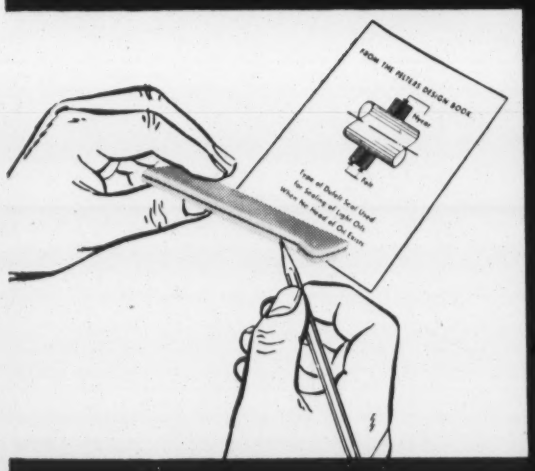
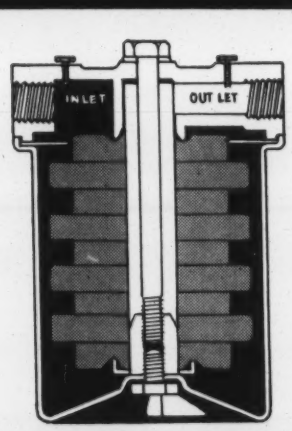




For Seals — Felters Dufelt is ideal for use as a seal with light oils, when no head of oil exists. Dufelt incorporates layers of Hycar, sandwiched with standard felts, in a number of different combinations.

Felters' Filtering Felts assure uniform densities for filtering a wide range of liquids and air. Includes oil, latex, cellulose products, gasoline, alcohol and similar media. Capillary value controlled by varying fibre density and grade.

Vibration Isolation and Cushioning can be effectively achieved by using special Unisorb Pad or Unisorb Level-Rite machine mounts. Prevents transmission of vibration to surroundings, improves operation of machine tools.

the **FELTERS** company
220 SOUTH ST., BOSTON 11, MASS.
Pioneer Producers of Felt and Felt Products

For more information, turn to Reader Service card, circle No. 452

Copper-Coated Strip, shown before heat-treat at Victor Adding Machine, prevents distortion of precision parts during case hardening of working surfaces.

Plain Steel number dials are welded to precision-made Thomas Strip.

Victor Adding Machine, Others Cut Costs, Improve Products With Thomas Strip

Manufacturers across the country are reporting new cost-cutting, quality-boosting results from their use of Thomas Strip's cold-rolled specialty steels.

At Victor Adding Machine Company, Chicago, for example, copper-coated Thomas Strip slashed one major production cost by 50% and made big savings in another operation.

Fred E. Rolli, Victor's chief engineer, says Thomas Strip is "the greatest single improvement in our production process in the past 10 years."

Here's why:

Victor's deluxe Model 75 contains 2500 individual parts, 68 of the most critical being made from Thomas Strip, both plain and copper-coated.

• **Distortion-Free.** Load-bearing parts—with tolerances under .001 inch, plus or minus, have to be case hardened along their sheared edges. Heat-treating plain steel (15 minutes at 1450 degrees) can warp the stamping. Often the expensive straightening process caused tiny surface cracks which elongated the part past the .001-inch tolerance.

To solve this problem, Victor turned to copper-coated Thomas Strip. Since the electrolytic layer of copper stops off or blocks carburizing gases, flat surfaces of the stamped part are protected. Then, plain steel edges case harden properly. The part retains flatness and proper ductility. Since there is no distortion, piece straightening of copper-coated parts is eliminated. This accounts for the 50% reduction of the total straightening operation at Victor.

• **More Savings.** A second economy begins in the punch press. Die-life is a vital factor of production costs. Like other users of copper-coated Thomas Strip, Victor finds die-life between grindings is extended as much as 33%. This is due to the lubrication effect of the copper coating.

A third benefit: uniform temper and on-spec composition of Thomas Strip mean clean, burr-free sheared edges. Burrs, like slivers, are banes of close-tolerance operation of machine parts.

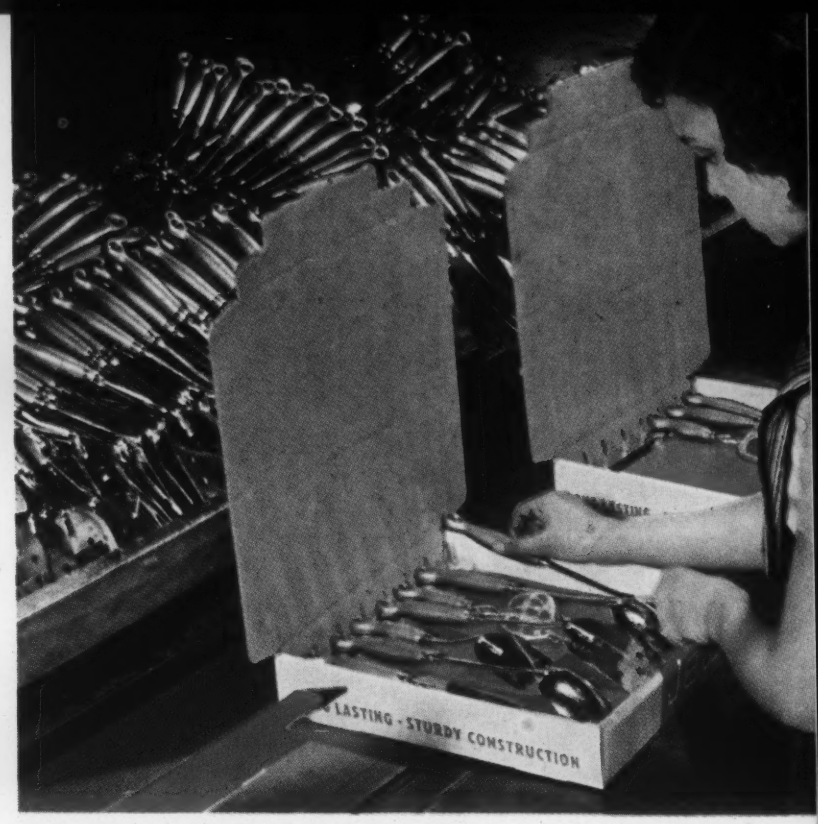
• **Satisfied.** Engineer Rolli sums it up by saying:

"Elimination of straightening is one of the biggest boons to small parts manufacturers that I've seen in the business. Even if Thomas Strip had no other benefits than eliminating a production problem, using copper-coated strip would be entirely worthwhile."

Thomas Strip's advantages are the same throughout industry. Other examples of how manufacturers cut costs, improve products—get higher profits and increase sales are shown here.

Thomas Strip's newly expanded and diversified production facilities give you the full range of products on these pages, in addition to zinc and chrome coatings . . . or hot-dip coated with lead alloy or tin. Uncoated Thomas Strip products include low carbon, alloy and high carbon spring steel grades.

Steel's Strength, Brass' Beauty are combined economically to form lock-joint tubing at Van Huffel Tube Corp., Warren, Ohio. Largest producer of rolled shapes in the nation, Van Huffel uses clear-lacquered, brass-coated Thomas Strip to make tubing for variety of products, including curtain rods and lamps. Thomas' brass and lacquer coatings easily withstand forming pressures and resist roll damage to the finish. Tubes usually need no further surface finishing. Van Huffel has been a satisfied Thomas Strip user for 26 years.



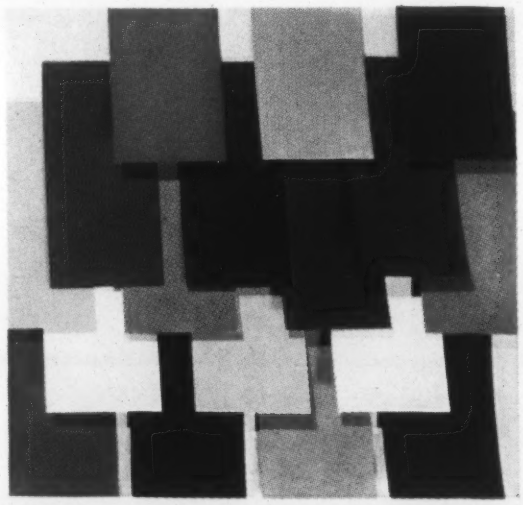
Capacity Up 25%, Sales Up 45% since Automatic Wire Goods Manufacturing Co., Bronx, New York, started using Thomas' nickel-plated strip 5 years ago. President Irving Spiegel says Thomas Strip boosted quality, kept production costs constant, improved appearance and design of his extensive Jewel and Automatic kitchen utensil lines. Thomas nickel-coated strip assures a mirror-like finish, an important feature of sales appeal in the highly competitive utensil field.

All Thomas Strip products can save you money and enhance your product in six important ways:

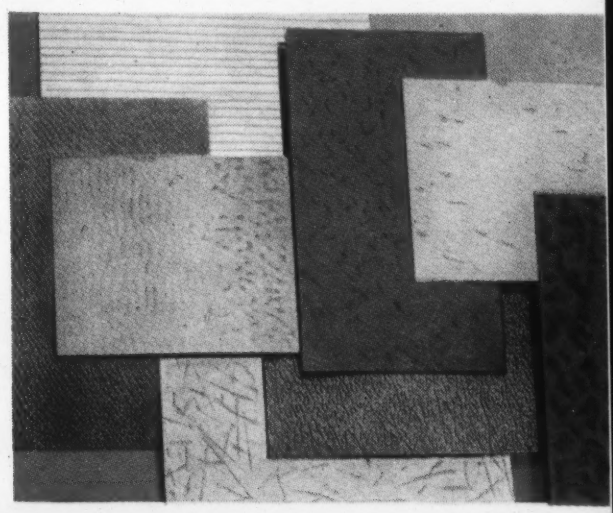
- **Fabricates Easily.** Coated steels stand fully as much fabrication as uncoated strip.
- **Longer Die Life.** Most coatings lubricate dies, reduce wear and increase tool life.
- **Maximum Pieces Per Pound.** Precision rolling to extremely close size tolerances gives more square feet of strip per ton.
- **Lower Plating Costs.** Coatings serve as final product finish or as base for further plating or painting.
- **Speeds Fabrication.** Thomas Strip coatings eliminate costly intermediate fabricating steps such as cleaning, buffing, even plating.
- **Steel's Strength and Economy** are combined with beauty and utility of more expensive metals.

All the savings and benefits Thomas Strip specialties are giving to fabricators shown here are available to you. A national sales staff—familiar with design and fabrication advantages of Thomas Strip is ready to serve you.

Write for samples, and additional cases of users' actual experiences with Thomas Strip products. Do it today!



The Rainbow's Range of colors, lacquered or painted on precision cold-rolled strip will solve your decorative and design problems. Thomas Strip's new lacquer line is the industry's finest. It's capable of wider widths in a fuller range of colors, especially pastel shades. Besides appearance, lacquer-coated steel is rugged and can be readily formed or mildly drawn without damage to the product's finish.



Unlimited Design opportunities come with pattern-rolled strip. New facilities enable Thomas to offer wider widths of any design and coating, including clear or colored lacquer. Users agree pattern-design enhances product sales appeal, permits production economies by eliminating piece buffing and costly further finishes. Pattern-designs stand up under tough forming operations and still offer attractive, flaw-free surfaces.

Thomas Strip® Division

Pittsburgh Steel Company

Grant Building · Pittsburgh 30, Pennsylvania

District Sales Offices:

Atlanta, Chicago, Cleveland, Dallas, Dayton, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, Tulsa, Warren, Ohio

Excellent Machinability of Magnesium Cuts Production Costs

Easy machining means faster machining, less wear on tools, lower costs

Designers working in today's highly competitive markets are finding it more important than ever to consider production costs when they're selecting materials. Magnesium alloys offer much needed economies in this respect. In fact, few other structural metals are so versatile and easy to work with in production operations.

Take machining, for example.

The excellent characteristics of magnesium alloys permit machining operations at extremely high speeds—usually at the maximum obtainable speeds of

MAXIMUM OPERATING SPEEDS of automatic machine tools can be utilized in machining magnesium.

modern machine tools. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium. The life of high speed steel cutting tools when machining wrought magnesium is equal to the life of carbide tipped tools when machining other metals!

Magnesium lightness, which allows easy, efficient handling of large parts, plus excellent machining characteristics add up to substantial savings in production costs.

TURNING AND BORING. A wide range of cutting speeds, feeds and depths of cut are possible in turning and boring magnesium. Rough cuts vary from 300 fpm, 0.100 ipr and 0.800″ in depth to 5,000 fpm, 0.010 ipr and 0.150″ deep. Finish cuts may vary from 300 fpm, 0.025 ipr and 0.100 inches to 5,000 fpm, 0.003 ipr and 0.050 inches.

MILLING. The outstanding machining characteristics of magnesium can be used to full advantage in milling operations. Heavy feeds and milling speeds up to 9,000 fpm remove the metal rapidly with excellent surface finish.

DRILLING. The maximum speeds of standard drilling equipment can be utilized to the fullest extent. Speeds used in commercial shops on other metals are 75 to 400 fpm, but speeds up to 2,000 fpm can be used with magnesium.

SAWING. Magnesium is readily cut with band, circular, hand or power hack saws. Because of the low cutting pressure, larger cuts can be taken per tooth than are possible with other metals.

AUTOMATIC SCREW MACHINE WORK. Extruded magnesium screw machine stock is available in all common sizes and shapes. It usually costs less on a cost-per-part basis than any other metal except steel. The use of magnesium permits feeds as much as 50% to 75% higher than those used with brass. Magnesium causes less tool wear, which lowers tool cost and reduces machine down time.

It is often possible to reduce part costs because of the low power consumption, the high feeds and speeds and the excellent surface finishes that result from using magnesium. The light weight of the metal exerts less wear on spindles, belts and motors, especially where quick changes of speed are involved.

TAPPING AND THREADING. Threads which are not held to close tolerances may be tapped in magnesium alloys with standard taps. Threads may be chased in magnesium alloys at the rate of 1,000 feet per minute.

GRINDING AND POLISHING. Finish grinding of magnesium is often unnecessary inasmuch as finishing cuts give extremely accurate and smooth surfaces. Rough grinding, however, is widely used in foundry clean-up and for removing flash from die castings and forgings.

Polished surfaces of any desired quality are easy to obtain on magnesium. Surface irregularities are removed readily by polishing operations. High lustre surfaces on articles to be plated or used for decorative purposes can be produced by buffing.

In all other machining operations, such as shaping and planing, reaming, counterboring and filing, the advantages of magnesium also pay off in terms of faster production, lower costs and less tool wear. Thousands of metalworking shops are efficiently and safely working with magnesium every day. Why not consider magnesium for the products or parts you're working with now?

METAL	RELATIVE POWER REQUIREMENT
magnesium	1.0
cast aluminum	1.8
brass	2.3
cast iron	3.5
rolled aluminum	5.0
mild steel	6.3

RELATIVE POWER required to machine different metals under the same conditions is shown by this comparison (1.0 = lowest power required).

MACHINING MAGNESIUM, a 60-page handbook, discusses all methods of machining mentioned above. Also includes tables on speed, feed and depths of cut, basic information on magnesium properties, tool design and safe procedures. For your copy, contact the nearest Dow office or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1453J-1.

YOU CAN DEPEND ON DOW

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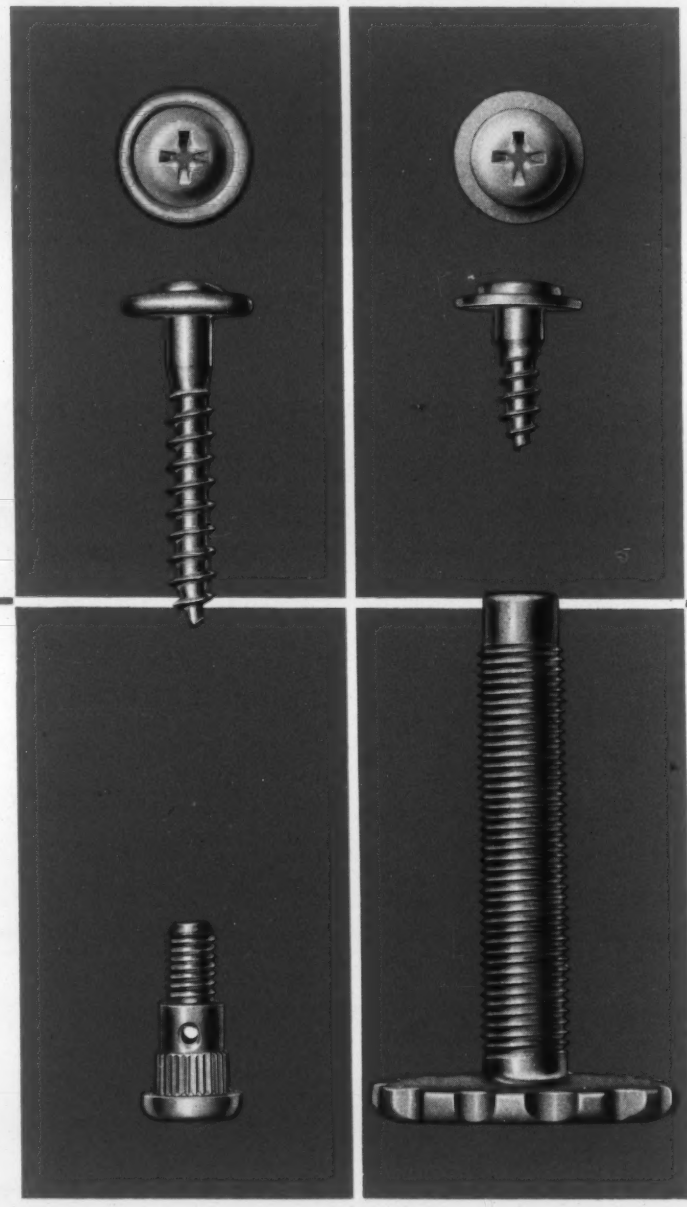
KEYSTONE XL WIRE

solved heading problems for

NATIONAL LOCK COMPANY
ROCKFORD, ILLINOIS

ONE Replaces TWO . . . by cold heading this Phillips washer head screw, National Lock replaced an oval head screw and finishing washer at a substantial cost savings. Regular wire caused cracked heads and required 100% inspection, so National Lock turned to Keystone "XL" Wire and eliminated cracking.



DESIGN PROBLEM SOLVED . . . this was an unsatisfactory 2-piece assembly, and a 1-piece Phillips washer head shoulder screw appeared to be needed. However, the design seemed too severe for cold heading. National Lock made this part a production item with Keystone "XL" Wire . . . and at a savings.

QUALITY AND QUANTITY . . . National Lock found it possible to have both when using Keystone "XL" Wire to economically produce this knurled shoulder screw. This part required a wire which could withstand a very severe extrusion and still fill out a sharp knurl to keep the part from turning in application.

INCREASE DIAMETER . . . National Lock reports this 1-piece cold headed leveling screw serves the same purpose as a 2-piece welded assembly, and the scalloped head fits 12-point socket wrenches. The use of Keystone "XL" Wire permits an increase in head diameter and a great reduction of cracked heads.

flowability IS THE SECRET

Illustrated above are four ways National Lock Company, Rockford, Illinois, has profitably put Keystone "XL" Wire and its *flowability* in action. Your Keystone representative will be glad to assist you in finding a solution to your heading problems. See him soon or write direct.

Keystone Steel & Wire Company, Peoria 7, Illinois

KEYSTONE
WIRE FOR INDUSTRY

Keystone Steel & Wire Company
Peoria 7, Illinois

COLD HEADING FACTS FOLDER . . . send coupon today! New folder discusses uses, applications, methods, technical facts, wire requirements.

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NEW and important from J&L STRIP STEEL DIVISION

exclusive

basic oxygen steel cold rolled strip

especially advantageous for deep drawing requirements

High purity, ductile, Basic Oxygen Steel is now available for the **first** time in restricted specification cold rolled strip. Low phosphorous, sulphur and nitrogen content characterize this new product. The combination of this high quality low carbon steel and the controlled processing typical of J&L's Restricted Specification Strip, results in a **new** product with many fabricating advantages. For deep drawing and intricate forming operations, superior yields and lower costs may be anticipated. The extent to which this new product may benefit your product deserves immediate investigation. Your inquiry will receive our prompt and interested attention.

J&L STRIP STEEL DIVISION produces a full line of restricted and standard specification strip steel in these grades and types:

- Low Carbon
- High Carbon
- Tempered Spring Steel
- Molten Zinc Coated (JalZinc)
- Electrolytic Zinc, Tin, Copper and Brass Coated
- Alloy
- Stainless
- Painted

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STEEL CORPORATION
STRIP STEEL DIVISION
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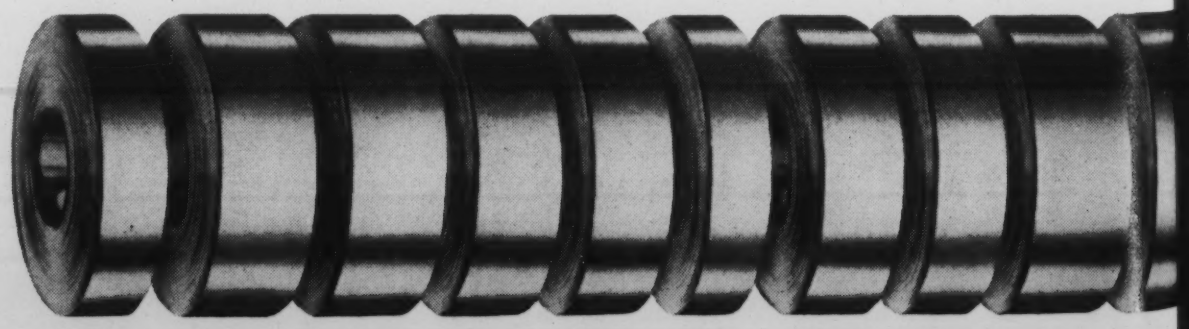

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Books, p 228

Reports, p 232

TECHNICAL LITERATURE

Suppliers' New Bulletins

Zinc Die Castings. Advance Tool & Die Casting Co., 6 pp, illus. Information on aluminum and zinc die castings. Shows company facilities. (1)

Coating Resins. Barrett Div., Allied Chemical Corp., 24 pp, illus. Properties and uses for oil-modified alkyd coating resins, urea and melamine coating resins, silicone-alkyds, modified phenolic resins, maleic resins, ester gums and pure phenolic resins. (2)

Anodized Aluminum. National Aniline Div., Allied Chemical Corp., 10 pp. A step-by-step description of a number of processes for coloring anodized aluminum. (3)

Plastics Sheets. Almac Plastics, Inc., 52 pp. Dimensions and prices for vinyl, acetate, phenolic, polyethylene, nylon, polystyrene, Teflon, Kel-F and Lucite sheet, rod and tube. (76)

Molybdenum Disulfide Lubricant. Alpha-Molycote Corp., 8 pp, illus., No. 304. Use of a molybdenum disulfide-filled lubricant in such metal forming operations as stamping, coining, cold heading, drawing, bending and punching. (4)

Aluminum Parts. Aluminum Co. of America, 20 pp, illus. Case histories on the use of aluminum screw machine stock in the manufacture of cameras, instruments, fishing reels, outboard motors and dictating machines. Includes a calculator for figuring mechanical properties. (5)

Bronze Castings. American Brake Shoe Co., 8 pp, illus. Properties and uses of bronze and copper centrifugal castings. Describes the centrifugal casting of bronze and copper parts. (6)

Nonferrous Shapes. American Brass Co., 20 pp, illus., No. B-28 S. Composition, forms and physical properties of copper, bronze, nickel silver, phosphor bronze, leaded brass and special brass alloys. Information also on copper tubes, pipe, electrical conduit and other nonferrous products. (7)

Conversion Coatings. American Chemical Paint Co., 8 pp. Information on various chemical conversion coatings for steel, aluminum, galvanized iron, and zinc and cadmium plated surfaces. (8)

Fused Silica. Amersil Co., Inc., 4 pp, illus. Physical characteristics, uses, electrical properties, heat resistance and sizes of fused silica tubing, pipe, crucibles and storage vessels. (9)

Aluminized Steel. Armco Steel Corp., 22 pp, illus. Corrosion resistance, mechanical properties, fire resistance and heat reflectivity of aluminized steel. Gives sizes, gages and available forms. (10)

Vinyl-Metal Laminate. Arvin Industries, Inc., 6 pp. Uses, design information, properties, fabrication and sizes for a vinyl-metal laminate. Contains an actual sample. (11)

Alloy Steel Tubing. Babcock & Wilcox Co., Tubular Products Div., 7 pp, No. 285. Chemical composition, sizes, mechanical properties, corrosion resistance, welding characteristics and comparative prices for a series of low nickel and austenitic stainless steel tubing. (12)

Thermal Insulation. Baldwin-Hill Co., 4 pp, illus. Physical and thermal characteristics, installation data, moisture resistance and uses for a mineral wool pipe insulation. (13)

Thermoplastic Resin. Marbon Chemical Div., Borg-Warner Corp., 4 pp, illus., Vol. 1, No. 3. Impact resistance, electrical properties, gloss retention and chemical resistance of a high impact thermoplastic resin molded into pencil sharpeners and outdoor displays. (14)

Boron Nitride. Carborundum Co., 4 pp, illus. Electrical properties, uses, corrosion resistance, chemical composition and thermal shock resistance of a machinable boron nitride. (15)

Rubber Anti-Oxidant. Catalin Corp. of America, 1 p. Solubility data and properties of an anti-oxidant for polyethylene, rubber and polystyrene. (16)

Composite Metal. Chicago Bridge & Iron Co., 32 pp, illus. Strength, ductility, uses of, and design information for, a composite metal called "Hortonclad." Lists a variety of available cladding and backing metals. (17)

TFE Gaskets. Chicago Rawhide Mfg. Co., Sirvene Div., 4 pp, illus., No. CT-1. Thermal, mechanical, frictional and chemical properties of Sirvene TFE packings, bearings, gaskets and rings. (77)

Plastics Tubing. Cobon Plastics Corp., 8 pp. Uses, sizes, dimensions and chemical resistance of polyvinyl chloride, polyethylene and Teflon plastics tubing. (18)

Teflon Tape. Connecticut Hard Rubber Co., 2 pp, illus. Properties, uses and sizes of a pressure sensitive Teflon tape and a Teflon-impregnated fiberglass tape for use at temperatures of —100 to 500 F. (19)

Alumina Ceramic. Coors Porcelain Co., 4 pp, illus. Mechanical and electrical properties, dimensions and uses of parts made from a dense, nonporous, 99% aluminum oxide ceramic. (20)

Specialty Steels. Crucible Steel Co. of America, 12 pp, illus. Discusses the use of specialty alloy, carbon, tool and stainless steels in heavy construction and mining machinery parts. Information also on stainless steel castings, hard facing electrodes and magnets. (21)

Vacuum Melted Alloy. Vacuum Metals Corp., Div. of Crucible Steel Co. of America, 4 pp. Chemical composition, applications and fatigue properties for a chromium-carbon steel produced by vacuum melting. Information on forging, annealing, hardening and tempering. (22)

Vapor Degreasing. Diamond Alkali Co., Chlorinated Products Div., 12 pp. Advantages and uses of perchlorethylene vapor degreasing for cleaning and preparing metal surfaces for electroplating, painting and other finishing operations. (23)

Metal Powder Parts. Dixon Sintaloy, Inc., 12 pp, illus. Applications, design information, chemical composition and physical properties for brass, iron, steel, nickel silver, bronze and copper metal powders. (24)

Fire Resistant Coatings. E. I. du Pont de Nemours & Co., Inc., Elastomer Chemicals Dept., 12 pp, illus., No. 80. Recent issue of *Elastomers Notebook* describes a simulated service test for evaluating fire resistant coatings. (25)

Wire, Metal Stampings. Eastern Tool & Mfg. Co., 24 pp, illus. Design information for, and uses and properties of, custom-made wire forms, deep

TECHNICAL LITERATURE

drawn parts and metal stampings. Shows company facilities. (26)

Plastics for Electronics. Emerson & Cuming, Inc., 4 pp. Brief descriptions of the company's epoxy casting resins, rod, sheet, surface coatings, adhesives, cements and sealants. Information also on epoxy, polyester and polystyrene foams. (27)

Steel Castings. Empire Steel Castings, Inc., 18 pp, illus. Shows company facilities for producing steel castings. (28)

Plastics Laminates. Farley & Loetcher Mfg. Co., Plastics Div., 4 pp. Sizes, uses, and mechanical and electrical properties for paper and fabric-base high pressure plastics laminates. (29)

Impregnated Felt. Felters Co., 4 pp, illus. Properties and uses for a thermoplastic resin-impregnated felt that can be electronically stitched and heat sealed. Contains an actual sample. (30)

Viscosity of Plastisols. Firestone Plastics Co., 32 pp, illus. Discusses the effects of shear rates, temperature and time on the viscosity of plastisols. (31)

Plastics Laminates. Formica Corp., 4 pp, illus. Sizes, uses, grades and a brief description of paper, canvas, linen, asbestos and glass-base laminated plastics. (32)

Plastics Tooling. Furane Plastics, Inc., 4 pp, illus. Use of epoxy resins, hardeners and parting agents in the manufacture of plastics tools. Shows typical epoxy tool fabrication. (33)

Plastics Laminates. General Electric Co., Laminated Products Dept., 16 pp, illus., No. 2b. Mechanical, physical, thermal and electrical properties of paper, fabric, asbestos and glass-base phenolic, silicone, polyester and epoxy laminates. Properties, uses and sizes of rolled and molded laminated plastics tubes. (34)

Aluminum Extrusions. General Extrusions, Inc., 6 pp, illus. Properties, uses, surface finishes, lengths and tolerances for a line of aluminum extrusions. (35)

Reinforced Plastics Parts. Bolta Products Div., General Tire & Rubber Co., 20 pp, illus., No. BN-1156-5. Uses, fabrication data, and electrical, physical, and chemical properties of a low pressure reinforced plastics sheet material called "Boltaron." (36)

Vinyl Resins. Goodyear Tire & Rubber Co., Chemical Div., 4 pp. Properties and uses for medium and low viscosity, general purpose vinyl resins. (37)

Epoxy Coatings. Hauger-Beegle Associates, Inc., 4 pp. Physical properties, chemical resistance, application data, and suggested uses for a line of epoxy decorative and maintenance finishes. (38)

Rubber Products. Hohwieler Rubber Co., 12 pp, illus. Shows typical rubber products including sheets, inflatable products, fabric-reinforced gaskets and special molded shapes. (39)

Beryllium Copper Parts. Instrument Specialties Co., Inc., 20 pp, illus., No. 10. Ductility, dimensional data, design information, physical properties and uses of strips, rings, springs and screw machine products made of beryllium copper. (40)

Electrical Insulation. Johns-Manville Corp., 2 pp. Thermal stability, dielectric strength, mechanical and chemical properties, and electrical properties after aging of a silicone-asbestos electrical insulation. (41)

Metal Fabrications. Koven Fabricators, Inc., 4 pp, illus. Shows facilities for hot dip galvanizing, finishing, stress relieving and x-ray inspection of welded and fabricated metal assemblies. (42)

Glass Fiber Insulation. L. O. F. Glass Fibers Co., 4 pp, illus. Insulation efficiency, uses, vibration and airflow resistance, compressibility, dimensional data and tensile strength of quartz and glass fiber thermal insulations. (43)

Baked-On Coatings. Lithcote Corp. of America, Inc., 4 pp. Information on baked-on phenolic, epoxy and other protective coating materials for tanks, tubing and industrial equipment. (44)

Lithium Products. Lithium Corp. of America, Inc., 4 pp. Properties and uses of lithium metal, lithium metal derivatives and special lithium ceramic compounds. (45)

Clad Steels. Lukens Steel Co., 32 pp, illus. Mechanical and chemical properties, sizes, uses, design information and fabrication data for a series of nickel, stainless steel, Inconel and monel-clad steels. (46)

Malleable Iron Castings. Malleable Founders' Society, 8 pp, illus. Design considerations, machinability, and impact and corrosion resistance of standard and pearlitic malleable iron castings. Includes commercial and government specifications. (47)

Industrial Ceramics. McDanel Refractory Porcelain Co., 4 pp, No. D358. Physical properties, design information and fabricating data for a series of alumina, porcelain and zirconia ceramics. (48)

Hard Surfacing. McKay Co., 20 pp, illus., No. HS-127. Mechanical properties, sizes and application data for a series of hard surfacing electrodes and welding wires. Lists over 500 different applications where hard surfacing can be used. (49)

Platinum-Clad Metals. Metals & Controls Corp., General Plate Div., 2 pp, illus., No. PLA-5. Physical properties, uses and design information for platinum-clad brass, stainless steel, iron, tantalum and bronze. (50)

Rubber Products. Miller Products Co., Inc., 28 pp, illus., No. MME-P. Specifications, properties and uses of molded, extruded and die-cut rubber packings, rods, rollers, washers and gaskets. (51)

Malleable Iron Castings. National Malleable & Steel Castings Co., 8 pp, illus. Chemical composition, physical properties, design information and machinability for pearlitic malleable iron and steel castings. Shows grain structures of various casting alloys. (52)

Phosphating Metal Surfaces. Neilson Chemical Co., 4 pp, illus. Operational data on, and advantages of, a cleaning and phosphatizing process for treating metal surfaces prior to painting. (53)

Rubber, Vinyl Parts. Ohio Rubber Co., 6 pp, illus., No. 715. Information on natural, synthetic and silicone rubber parts, and molded and extruded plastics parts. Shows company facilities. (54)

Electrical Insulation. Owens-Corning Fiberglas Corp., Electrical Div., 598 Madison Ave., New York 22. Chemical resistance, design information, application data and uses for fiberglass cordage and sealing thread used in electrical insulations. Write on company letterhead directly to Owens-Corning.

Tapes. Permacel-Lepage's, Inc., 4 pp, illus. Outlines features and uses of the company's line of acetate fiber, cloth, Mylar, cellophane, paper and electrical tapes. (55)

Anodized Aluminum Wire. Permaluster Inc., 1 p. Electrical properties and heat resistance of an anodized aluminum wire used in electrical and electronic devices. (56)

Wire Rope. Leschen Wire Rope Div., H. K. Porter Co., Inc., 16 pp, illus. Information on strength, bending resistance, vibrational fatigue, and abrasion and crushing resistance of wire rope. Lists typical applications. (57)

Plastics Pipe. Republic Steel Corp., 18 pp, illus. Working pressures, sizes, uses, joining data, mechanical and physical properties, and chemical resistance of flexible and semi-rigid plastics pipe. (58)

Cold Finished Steel. Republic Steel Corp., Union Drawn Div., 30 pp, illus. Guide to the proper selection of cold finished steel bars. Technical data on carbon, free machining, leaded and stainless steels. (59)

Rigidized Metals. Rigidized Metals Corp., 32 pp, illus. Physical properties, applications, sizes and pattern numbers for a series of colored and uncolored rigidized metal panels. Case histories on the use of these materials in such products as gasoline pumps and carpet sweepers. (60)

Aircraft Steels. Joseph T. Ryerson & Son, Inc., 70 pp. Information on Army, Navy and Government aeronautical specifications. Weights and dimen-

sions of alloy and stainless steel shapes to meet these specifications. (61)

Epoxy Coatings. Shell Chemical Corp., 12 pp, illus. Flexibility, adhesion, chemical and abrasion resistance, uses, application data, and color and gloss retention for epoxy coating materials. (62)

Nylon Resins. Spencer Chemical Co., 28 pp, illus. Mechanical, electrical and physical properties; moldability; chemical resistance; and machinability for low, medium and high viscosity nylon resins. (64)

Polysulfide Sealants. Thiokol Chemical Corp., 8 pp, No. 2-58. Properties, application data and uses for aluminum colored, polysulfide liquid sealants and fillers. (65)

Cellular Products. Toyad Corp., 4 pp. Physical properties and uses for a series of flexible and rigid neoprene, polyurethane, nitrile and vinyl cellular products. (66)

Corrosion Resistant Coating. Tube Reducing Corp., Niphos Process Div., 4 pp, illus. Corrosion and abrasion resistance, ductility, weldability and brazability of a nickel-phosphide coating called "Niphos." (67)

Silane Finishes. Union Carbide Corp., Silicones Div., 8 pp, illus., No. SF-1094A. Shows how silane finishes improve moisture resistance, heat stability, electrical properties and strength of glass-reinforced polyester, phenolic, epoxy and melamine resins. (68)

Low Temperature Insulation. United Cork Companies, Uni-Crest Div., 5 pp. Physical properties, sizes, installation data and bonding characteristics for an expanded polystyrene insulation for low temperature applications. (69)

Plastics Foam Insulation. U. S. Rubber Co., Ensolite Div., 6 pp, illus. Insulation efficiency and shock absorbing qualities of a family of flexible, unicellular expanded plastics foams. Includes physical properties and typical applications. (70)

Drop Forgings. J. H. Williams & Co., 20 pp, illus. Shapes and sizes of forgings made from carbon, alloy and stainless steel, monel, brass, bronze, copper, aluminum and titanium. Shows facilities for producing these forgings. (71)

Rubber Parts. Williams-Bowman Rubber Co., 1 p. Dimensional tolerances for extruded and molded rubber products, gaskets, washers and rubber-covered rolls. Parts are made of natural and synthetic rubber. (72)

Cold Rolled Metal. Yoder Co., 88 pp, illus. Tells how to produce a wide variety of metal shapes by cold roll forming. Shows the use of cold formed moldings, trim and tubular shapes in a number of products. (73)

Manganese Steel. Youngstown Sheet & Tube Co., 4 pp, No. 847M2. Chemical composition, physical properties, corrosion resistance, and welding information for a series of manganese-containing high strength steels. (74)

Sandwich Construction. Zahorski Engineering, Inc., 4 pp, illus. Applications, strength and fabrication data for a structural sandwich that is available in stainless steel, titanium, aluminum and fiberglass. (75)

Other Available Bulletins

Irons & Steels • Parts • Forms

Stainless Castings. Allegheny Ludlum Steel Corp., 28 pp, illus. Data on corrosion and heat resisting stainless steel castings. (80)

Spun Steel Tubing. American Cast Iron Pipe Co., Special Products Div., 64 pp, illus. Dimensional data, physical properties and applications of spun steel tubing. (81)

Wire Parts, Small Stampings. Art Wire & Stamping Co., 4 pp, illus. Shows a variety of wire parts and small metal stampings produced in both ferrous and nonferrous metals. (82)

Metal Stampings. Crosby Co., 40 pp, illus. Describes company's facilities for metal stamping. (83)

Castings. Curtiss-Wright Corp., Metals Processing Div., 10 pp, illus. Describes facilities for research, development and production of castings. (84)

Welded Stainless Tubing. Damascus Tube Co., 6 pp, illus. Explains how welded stainless steel tubing is manufactured. (85)

Stainless Steel. Eastern Stainless Steel Corp., 4 pp, illus. Describes Type 321 SW grade of sheet and plate resulting from new method of melting ingots. (86)

Steel Rings. Edgewater Steel Co., 12 pp, illus. Describes a process by which rolled steel rings are formed from solid blocks of steel. (87)

Metal Stampings. Federal Tool & Mfg. Co., 4 pp, illus., No. 201. Information on small quantity metal blanking, forming, drawing, extruding, stenciling, drilling and tapping. (88)

Formed Tubes. Formed Tubes, Inc., 16 pp, illus. Describes company's facilities for manufacturing tubing of various metals and alloys. (89)

Pearlitic Malleable Castings. Central Foundry Div., General Motors Corp., 11 pp, illus. Provides engineering data on Armasteel castings, plus machining information. (90)

Cast Iron Specifications. Gray Iron Founders' Society, Inc., 4 pp. Covers gray and nodular (ductile) cast irons and cast pressure pipe, soil pipe, valves and fittings. (91)

Drawn Metal Shapes. Hydroforming Co. of America, 6 pp, illus. Shows savings achieved on tooling costs by using Hydroforming, a custom, deep drawing service. (92)

Extruded Shapes. Jones & Laughlin Steel Corp., 12 pp, illus. Sizes, mechanical properties, shapes, quantities and applications of hot extruded, cold drawn sections. (93)

Steelmaking. Jones & Laughlin Steel Corp., Stainless Steel Div., 12 pp, illus. Color photographs illustrate the various steps in steelmaking. (94)

Steel Wire. Keystone Steel & Wire Co., 12 pp, illus., No. 1a Ke. Illustrates various kinds of steel wire and discusses cold heading. (95)

Steel Research. LaSalle Steel Co., 8 pp, illus. Outlines facilities, organization and services of the research and development department of LaSalle. (96)

Copper Coated Wire. National-Standard Co., Wagner Litho Machinery Div., 8 pp, illus., No. 202. Uses, corrosion resistance, strength, electrical resistivity and bend strength of copper coated wire in sizes from 0.043 to 0.0310 in. (97)

Zinc Coated Steel. Weirton Steel Co. Div., National Steel Corp., 8 pp, illus. Outlines advantages, uses and properties of zinc coated steel sheets. (98)

Steel Die Forgings. Park Drop Forge Co., 8 pp, illus. Information on closed die forgings made of carbon, alloy, stainless and heat resisting steels in sizes from 5 to 5000 lb. (99)

Steel Wire. Pittsburgh Steel Co., 120 pp, illus. Sizes, tensile strength and chemical composition of approximately 100 types of steel wire. (100)

Coated Steel Strip. Thomas Strip Div., Pittsburgh Steel Co., 20 pp, illus. Contains actual samples of strip steel electrolytically coated with zinc, copper, brass, lead alloy, nickel and chromium, in natural and buffed finishes. (101)

Steel Bars. Connors Steel Div., H. K. Porter Co., Inc., 4 pp, illus. Properties and uses of steel bars and structural sections that are hot rolled or cold finished to customer specifications. (102)

Roll Formed Shapes. Roll Formed Products Co., 26 pp, illus. Information on roll formed shapes produced from both ferrous and nonferrous metals. (103)

Spring Steels. Sandvik Steel, Inc., 6 pp, illus. Sizes, materials and chemical composition of spring and specialty strip steels. (104)

Steel Patterns. Sharon Steel Corp., 16 pp, illus. Advantages, applications, fabrication, availability and design of surface rolled steel patterns. (105)

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Metal Stampings. Standard Stamping & Perforating Co., 114 pp, illus. Catalog of standard stamped and perforated patterns. (106)

Powder Metallurgy. F. J. Stokes Machine Co., 35 pp, illus. Shows how parts are made from ferrous and nonferrous metal powders. (107)

Steels. Timken Roller Bearing Co., Steel & Tube Div., Canton, Ohio. Complete catalog of steels. Write on company letterhead directly to Timken.

Small Metal Parts. Torrington Co., 4 pp, illus. Describes small custom metal parts such as pins and pivots, clock rotor shafts and gear studs. (108)

Steel Strip. American Steel & Wire Co. Div., U.S. Steel Corp., 48 pp, illus. Physical properties, dimensions, tempers and finishes of cold rolled stainless and carbon steel strip. (109)

Electrolytic Iron. Van der Horst Corp., 4 pp, illus. Uses, properties and applications of Vanderloy, an electrolytic iron. (110)

Cold Formed Parts. Van Huffel Tube Corp., 48 pp, illus. Information on cold formed metal parts. (111)

Vanadium Steels, Irons. Vanadium Corp. of America, 83 pp, illus. Gives chemical composition, heat treatment, physical properties and uses of vanadium-containing steels and irons. (112)

Investment Casting Alloys. Wai-Met Alloys Co., 4 pp, illus. Information on tool and stainless steel certified alloys for investment castings. (113)

Stainless Steel. Washington Steel Corp., 28 pp, illus. Physical properties, chemical composition, corrosion resistance, and availability of a nickel-free stainless steel called Microrold 430. (114)

Nonferrous Metals
• Parts • Forms

Investment Castings. Alloy Precision Castings Co., 2 pp, illus. Chemical composition and physical properties of ferrous and nonferrous alloys for investment castings. (119)

Bronze Electrodes. Ampco Metal, Inc., 4 pp, illus., No. W-25a. Applications, characteristics, properties and sizes of bronze electrodes. (120)

Nonferrous Castings. Atlantic Casting & Engineering Corp., 12 pp, illus. Information on nonferrous castings cast to ordinary machining tolerances. (121)

Investment Castings. Austenal Laboratories, Inc., Microcast Div., 12 pp, illus. Describes Microcast process and gives properties of investment cast alloys. (122)

Aluminum Impact Extrusions. Hunter Douglas Aluminum Div., Bridgeport Brass Co., 44 pp, illus. Gives a step-by-step description of backward and forward aluminum impact extrusions. (123)

Nonferrous Tubing. Wolverine Tube Div., Calumet & Hecla, Inc., 4 pp, illus. Uses and properties of a finned aluminum condenser tube. (124)

Metal Powder Shapes. Amplex Div., Chrysler Corp., 52 pp, illus. Data on Oilite metal powder shapes, including sleeve, flange and thrust bearings; cored and solid bar; and plate stock. (125)

Zirconium Metal. Columbia - National Corp., 8 pp, illus. Reviews established and potential applications for zirconium metal, gives physical properties, and discusses methods of fabrication. (126)

Die Castings. Dollin Corp., 16 pp, illus. Booklet describes plant and facilities for making die castings. (127)

Magnesium-Thorium Alloys. Dow Chemical Co., 14 pp, illus. Discusses the radioactivity of thorium-containing alloys. Information on welding, pickling and chemical milling. (128)

Alloy Handbook. Wilbur B. Driver Co., 150 pp, illus. Manual on company's alloys, technical services, plants and facilities. (129)

Static and Centrifugal Castings. Duraloy Co., 16 pp, illus., No. 3354-G. Describes facilities for producing high alloy static and centrifugal castings. (130)

High Density Metal. Fansteel Metallurgical Corp., 16 pp, illus. Properties and uses of Fansteel 77 Metal—a machinable tungsten-copper-nickel alloy. (131)

Nonferrous Tubing. Fromson Orban Co., 4 pp, illus. Lists some of the fields this company serves and the products supplied in aluminum, brass and copper tubing. (132)

Laminated Metals. General Findings & Supply Co., and Leach & Garner Co., 8 pp, illus. Sizes and forms of precious and laminated metals for electronic, aircraft and automotive parts. (133)

Electrical Contact Materials. Gibson Electric Co., 16 pp, illus., No. C-520. Properties and uses of electrical contact materials, including fine silver, palladium, nickel, silver alloys and silver cadmium oxides. (134)

Metal Powders. Chemical - Pigments - Metal Div., Glidden Co., 6 pp. Information on lead and Resistox copper powders. (135)

Zinc Die Castings. Gries Reproducer Corp., 8 pp, illus. Design information and physical data on zinc alloys for die castings. (136)

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of copper and brass tubing. (137)

Brass, Aluminum Parts. Hampden Brass & Aluminum Co., 24 pp, illus. Information on brass and aluminum castings and reinforced plastics products. (138)

Powder Metallurgy. Harper Electric Furnace Corp. Bibliography of powder metallurgy articles printed in 1954 and 1955 in the United States, England and Canada. (139)

Die Castings. Ainsworth Precision Div., Harsco Corp., 24 pp, illus. Describes facilities for producing aluminum, magnesium and zinc die castings. (140)

Aluminum Structures. Harvey Aluminum Sales, Inc., 12 pp, illus. Properties and structural applications for aluminum extrusions. (141)

Investment Castings. Hitchiner Mfg. Co., 16 pp, illus. Outlines major advantages of both ferrous and nonferrous investment castings. (142)

Indium Alloys. Indium Corp. of America, 93 pp, graphs. Discusses constitution of indium alloy systems. (143)

Nickel Alloys. International Nickel Co., Inc., illus. Properties of nickel alloys at low temperatures. Data cover only those materials in current use. (144)

Rare Earths. Lindsay Chemical Co., 12 pp, illus. Describes company's work in the rare earth field. (145)

Copper Tubing. Mackenzie Walton Co., 4 pp, illus. Facilities for producing precision nonferrous seamless tubing, particularly capillary, thin wall and braided tubing. (146)

Zirconium Alloys. Magnesium Elektron, Inc., 12 pp, illus. Chemical composition and properties of two magnesium-zirconium alloys. Shows miscellaneous aircraft castings made from these alloys. (147)

Alloying Metal. Mallinckrodt Chemical Works, 6 pp, illus. Discusses the use of misch metal (cerium) in high nickel alloys, magnesium and nodular iron. (148)

Aluminum Bronze. Mueller Brass Co., 7 pp, illus. Chemical and mechanical properties and uses of Tuf-Stuf, high copper-base alloys. (149)

Nonferrous Powder Parts. New Jersey Zinc Co., 4 pp, illus. Advantages of nonferrous powder parts in product engineering with emphasis on brass powder parts. (150)

Copper Tubing. Penn Brass & Copper Co., 6 pp, illus. Features of this company's seamless copper tubing. Includes tables of safe internal working pressures of various tubing sizes. (151)

Phosphor Bronze. H. K. Porter Co., Inc., Riverside-Alloy Metal Div., 4 pp, illus., No. T-4. Outlines advantages, applications and features of a fine grain phosphor bronze. (152)

Aluminum Extrusions. Precision Extrusions, Inc., 12 pp, illus., No. 5702. Information on aluminum extrusions. Properties and uses of extruded aluminum alloys are given. (153)

Aluminum. Reynolds Metals Co., 6 pp, illus. Graphs show yearly corrosion rates of more than 100 chemicals on aluminum. (154)

Aluminum Strip. Scovill Mfg. Co., 20 pp, illus. Physical characteristics, weights and fabricating data for aluminum alloy strip. (155)

Nonferrous Alloys. Seymour Mfg. Co., 40 pp, illus. Extensive technical data

on nickel silver and phosphor bronze, as well as cleaning and annealing information. (156)

Corrosion Resistant Alloys. Haynes Stellite Co., Union Carbide Corp., 104 pp, illus. Corrosion resistance, chemical compositions, and physical, mechanical and high temperature properties of four nickel-base alloys. (157)

Copper-Base Castings. Waukesha Foundry Co., 8 pp, illus. Applications, physical properties, chemical composition and advantages of copper-base, high nickel castings. (158)

Aluminum Extrusions. R. D. Werner Co., Inc., 4 pp, illus. Information on sizes and uses of aluminum extruded and roll formed shapes. (159)

Light Metal Forgings. Wyman-Gordon Products Corp., 4 pp, illus. Information on large light alloy forgings, particularly those of magnesium and 7075 aluminum. (160)

Plastics & Rubber
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Acrylic Rods, Tubes. Ace Plastic Co., 4 pp, illus. Illustrates range of acrylic rods, tubes and shapes used in the electronics industries. Tables show dielectric strength and chemical resistance. (166)

Polyethylene. American Agile Corp., 4 pp, illus. Mechanical, chemical and electrical properties, ultraviolet resistance and uses of Agilene-HT, an irradiated polyethylene. (167)

Sealing Compounds. Presstite-Keystone Engineering Products Div., American Marietta Co. Pictures and captions show sealing compound applications in the automotive and refrigerator industries. (168)

Filler for Nylon. Climax Molybdenum Co. Div., American Metal Climax, Inc., 4 pp, illus., No. Lu-12. Describes use of molybdenum disulfide as a filler in nylon, phenolic laminates, Teflon, natural and synthetic rubber and in asbestos. (169)

Reinforced Molding Compounds. Atlas Powder Co., Chemicals Div., 34 pp. Physical, mechanical, chemical and electrical properties of low pressure, reinforced polyester molding compounds. (170)

Teflon Parts. Continental-Diamond Fibre Corp., Div. of Budd Co., Inc., 8 pp, illus., No. GST-58. Mechanical, electrical and chemical properties of glass-supported Teflon sheets, tapes, laminates, metal-clad and fabricated parts. (171)

Plastics Pipe. Carlon Products Corp., 4 pp, illus. Answers most frequently asked questions about carbon flexible plastics pipe and carbon rigid pipe. (172)

Corrosion Resistant Plastic. Ceilcote Co., Inc., 12 pp, illus. Chemical resistance, physical properties, sizes and workability of a corrosion-proof thermosetting plastic reinforced with glass and synthetic fibers. (173)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Dimensions of molded and extruded rubber with cross sectional illustrations. (175)

Urethane Foams. Dayton Rubber Co., 14 pp, illus. Electrical, mechanical and thermal properties of urethane foams. Charts show aging, compression and stress-strain properties. (176)

Teflon. Dixon Corp., 4 pp, illus. Chemical and heat resistance and low coefficient of friction of the company's TFE resin called Rulon. (177)

Plastics Lining. Dow Chemical Co., 18 pp, illus., No. 171-77. Properties, installation data and uses of a flexible, vinylidene chloride, chemical resistant lining for storage tanks and fume ducts and hoods. (178)

Silicone Molding Compounds. Dow Corning Corp., 4 pp, illus., No. 7-603. Heat stability, physical and electrical properties, moisture absorption, thermal conductivity and corrosion and fungus resistance of silicone resin molding compounds. (179)

Polyester Film. E. I. du Pont de Nemours & Co., Inc., Film Dept., 8 pp, illus. Uses and physical and chemical properties of Mylar polyester film. (180)

Polyethylene Film. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., 8 pp, illus. Characteristics, properties and applications for film made from Alathon polyethylene resins. (181)

Teflon Products. Ethylene Chemical Corp., 1 p., illus. Dimensional data, sizes and other features of the company's line of Teflon sheets, extrusions, moldings, pipe and hose liners. (182)

Injection Molding Compounds. Fiberfil, Inc., 4 pp. Physical, electrical and chemical properties of Fiberfil Styrene G and Nylon G glass-reinforced injection molding compounds. (183)

Silicone Selector. Silicone Products Dept., General Electric Co., 4 pp, illus., No. AA 24 E. Lists major categories and properties of silicone compounds. Cross references to AMS and ASTM specifications are included. (184)

Latices for Textiles. B. F. Goodrich Chemical Co., 16 pp. Uses and properties of Hycar synthetic rubber latices in the textile industry. (185)

Custom-Made Rubber Parts. Goshen Rubber Co., Inc., 8 pp, illus. Information on development and production of custom-made rubber parts. (186)

Corrugated PVC Sheets. H. M. Hartwell & Son, Inc., Industrial Plastics Div., 24 pp, illus. Lining procedures for corrugated PVC sheet liners. (187)

High Density Polyethylene. Hercules Powder Co., Cellulose Products Dept., 6 pp. Properties and uses of Hi-fax, a high density polyethylene made by the Ziegler process. (188)

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Phenolic Molding Compound. Durez Plastics Div., Hooker Electrochemical Co., 4 pp, illus. Information on a medium impact phenolic molding compound including tensile strength, shrinkage and water absorption. (189)

Teflon Linings. Metalweld, Inc., Protective Coatings Div., 4 pp, illus. Physical properties and uses for a cementable Teflon lining for table tops, electrical insulation, tanks and mixers. Company applies linings at its own or customer's plant. (190)

Sandwich Core. Narmco Resins and Coatings Co., 6 pp. Formable core material for aluminum sandwich constructions where small-radius curves are needed. (192)

Polyethylene Processing. U. S. Industrial Chemicals Co., Div. of National Distillers Products Corp., 6 pp, illus. Discusses polyethylene processing with emphasis on reduction of warpage in injection molding and choice of the right resin for polyethylene wire coating. (193)

Laminated Plastics Comparator. National Vulcanized Fibre Co., 4 pp. Electrical, mechanical, physical and chemical properties of phenolic, melamine, polyester, epoxy and silicone laminated plastics are compared. (194)

Nylon Molding Powder. National Polymer Products, Inc., 2 pp, illus. Properties of Nylatron GS, a molybdenum disulfide-filled nylon molding powder. (195)

Plastics Parts. Pipco International Corp., 20 pp, illus., No. 501. Color, sizes and prices of nylon, polyethylene and butyrate bearings, gears, closures and spacers. (196)

Teflon Products. Raybestos-Manhattan, Inc., Plastic Products Div., 8 pp. Typical applications, properties and sizes of Teflon and Raylon (reprocessed Teflon) sheets, tapes, and molded and extruded rods and tubes. (197)

Molded Plastics. Richardson Co., 8 pp, illus. Manual on molded plastics for automotive, electrical, appliance and industrial applications. Case histories of 12 different applications. (198)

Gasket Materials. Rogers Corp., 13 pp, illus. Forms available and physical and chemical properties of a gasketing material for electrical insulation, gaskets and filters. (199)

Rubber. Roth Rubber Co., 1860 S. 54 Ave., Chicago, Ill., Rubber Sampler No. MM3. Actual rubber samples with hardness from 5 to 100 durometer. Write on company letterhead directly to Roth.

Vulcanized Fibre Products. Spaulding Fibre Co., 36 pp, illus. Properties of vulcanized fibre sheets, rods and tubes and fabricated parts. (200)

Laminated Plastics. Synthane Corp., 6 pp, illus. Properties and dimensions for six grades of metal-clad plastics laminates for printed and etched circuits. (201)

Laminated Plastics. Taylor Fibre Co., Norristown, Pa., 4 pp, illus. Information on rolled copper-clad plastics laminates that can be converted to printed circuits by photographic, silk-

TECHNICAL LITERATURE

screen and offset printing. Write on company letterhead directly to Taylor.

Plastics Guide. Bakelite Co., Div. of Union Carbide Corp., 16 pp, illus. Gives fabricating techniques, applications and properties of polyethylenes, vinyls, phenolics, styrenes, epoxies and polyesters. (202)

Kel-F Laminates. U. S. Gasket Plastics Div., Garlock Packing Co., 4 pp, illus., No. AD-152. Properties of a corrosion resistant Kel-F plastics lining material. Gives typical applications and tells how to apply the material. (203)

Plastics Pipe. National Tube Div., U. S. Steel Corp., 28 pp, illus., No. 24. Data on unplasticized rigid polyvinyl chloride pipe, both normal and high impact types. (204)

Extruded Plastics, Rubber. Conneaut Rubber & Plastics Co. Div., U. S. Stoneware Co., 4 pp, illus., No. CR-53. Die making and production facilities for rubber and plastics extrusions. (209)

Synthetic Rubber Products. Western Felt Works, Acadia Synthetic Products Div., 6 pp, illus. Shows various types of molded, extruded, die cut and lathe cut synthetic rubber parts and sheets. (205)

Plastics Laminate. Westinghouse Electric Corp., Micarta Div., 8 pp, illus., No. B-6577. Information on construction and properties of copper-clad plastics laminates for printed circuits. (206)

Fiberglass-Reinforced Plastics. White Sewing Machine Corp., Apex Reinforced Plastics Div., 4 pp, illus. Case histories of custom molded fiberglass parts. (207)

Stabilizing Vinyl Resins. Witco Chemical Co.. 24 pp. Discusses various types of stabilizers for vinyl resins. (208)

Other Nonmetallics • Parts • Forms

Glass Fabrics. Coast Mfg. & Supply Co., 20 pp, illus. Describes a line of glass fabrics and discusses resin systems for impregnating fabrics and papers. (214)

Glass. Corning Glass Works, 16 pp, illus., No. B-83. Mechanical, thermal, electrical and chemical properties of alumino-silicate glass and radiotron tube and capacitor glass. (215)

Friction or Damper Parts. World Bestos Div., Firestone Tire & Rubber Co., 4 pp, illus., No. 648. Available molded parts—brake linings and blocks, transmission linings, clutch facings and thrust washers. (217)

Ceramic Parts. Centralab Div., Globe-Union Inc., 16 pp, illus. Properties, uses and specifications for a series of alumina and other ceramic materials. Information on metallizing ceramics. (218)

Graphite. Graphite Specialties Corp., 4 pp., No. GS-101-1. Chemical and physical properties of an impervious graphite, more than 99.5% pure carbon, for high temperature parts. (219)

Titanium Carbide Alloys. Kennametal, Inc., 12 pp, illus. Design information, physical and thermal properties and corrosion resistance of titanium carbide alloys. (220)

Custom Glass. Lancaster Glass Corp., 27 pp, illus. Information on lead glasses for electronics, heat resisting borosilicate glasses, lime glasses and other glasses. (221)

Tungsten Carbide. Metal Carbides Corp., 24 pp, illus. Information on tungsten carbide products produced by both hot and cold pressed methods. Shows company facilities. (222)

Mica Insulation. Mica Insulator Div., Minnesota Mining & Mfg. Co., 20 pp, illus. Thicknesses and dielectric strengths of mica rings, tubes, plates, sheets and tapes available for Class B, H and C electrical insulations. (223)

Carbon Parts. Morganite, Inc., 12 pp, illus. Chemical and physical properties and sizes of carbon parts. (224)

Cork, Magnesia Insulations. Mundet Cork Corp., Insulation Div., 4 pp, illus. Brief description of a series of wool felt, expanded polystyrene, magnesia and cork insulations for use at high temperatures. (225)

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Carbon Graphite. Pure Carbon Co., Inc., 12 pp, illus., No. 55. Catalog on carbon graphite for mechanical applications. (227)

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Insulating Materials. Westinghouse Electric Corp., illus., No. B-7206. Types, characteristics and applications of Class A shellac and varnish-coated papers and organic varnished glass. Also discusses Class H insulations. (230)

Finishes • Cleaning and Finishing

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Joining & Fastening

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UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Gold color finish attracts the eye and repels corrosion

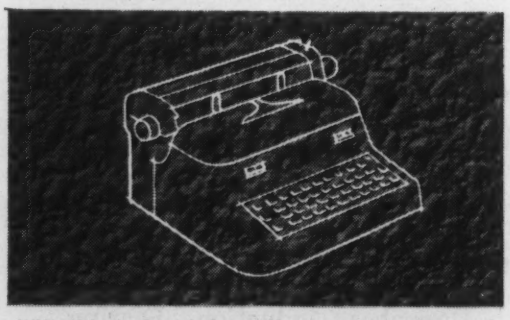
Vinyl finish sprayed to look like morroco leather

Something new for product designers is Unichrome Coating 6400 — a textured, highly mar-resistant protective finish. It can add distinction and durability to any product. It has a costly grained leather look, yet is applied by spray, in thicknesses of up to 20 mils per coat.

WITHSTANDS ABUSE

This finish is hard yet flexible. By as much as 10 to 1, it outlives ordinary textured enamels under abrasive and abusive service conditions. Taber abrasion tests show only 35 mg. loss in 1000 cycles vs. 350 mg. for the enamels.

Being a vinyl finish, Coating 6400 withstands chemicals, corrosives, moisture. It doesn't stain, is easy to clean. The surface can be varied from matte to gloss. It also insulates electrically, and helps to muffle sound. Send for new bulletin.



With this textured decorative and protective coating, products get the quality finish that befits them.

METAL & THERMIT
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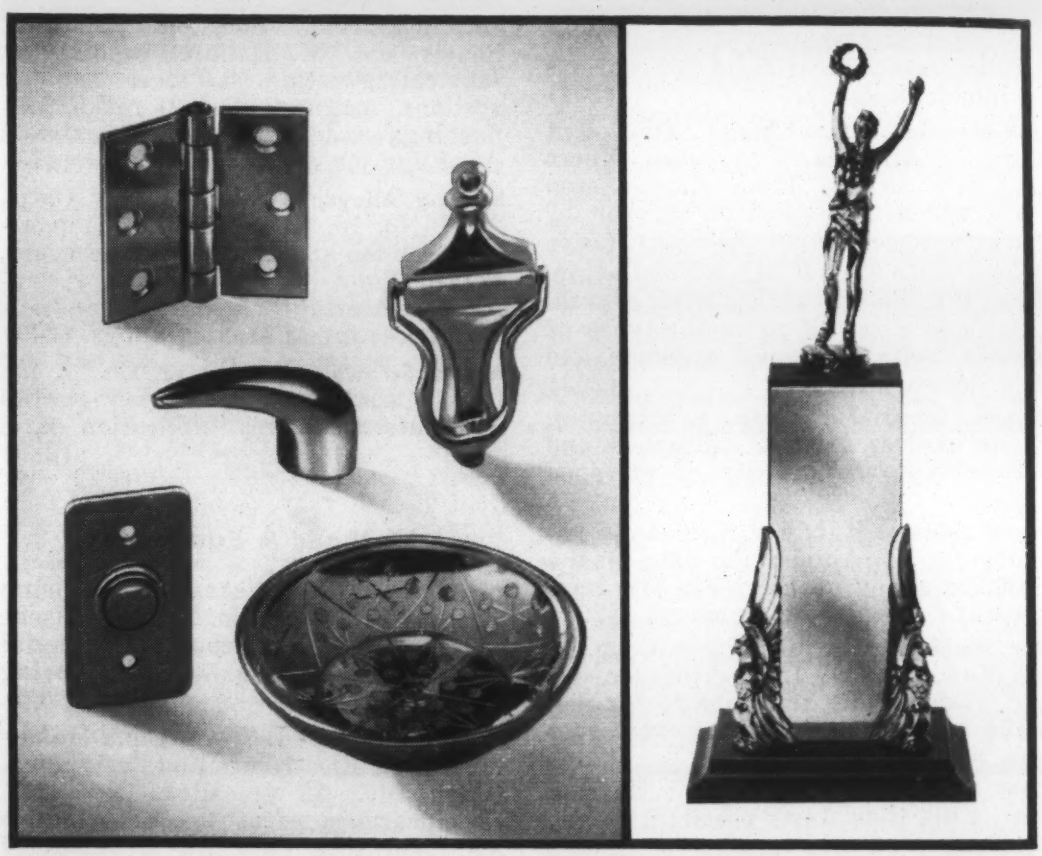

Products finished with M&T Bronze rival gold in appearance, in consumer appeal. Applications are wide as a designer's imagination.

M&T Bronze plating process produces uniform copper-tin plate at high speed

All may not be true gold that glitters, but improved M&T Bronze certainly is the image of the 24K kind.

This distinctive bronze is 88% copper, 12% tin — with uniform color and coverage even on complicated shapes. The finish reflects more depth and character than brass plate; demonstrates more durability than copper. It is a one plate finish, more economical than the copper-nickel-gold it has replaced on trophies, for example.

DURABLE FINISH

M&T Bronze, in addition to its eye-appeal, offers corrosion resistance superior to that of copper. A clear lacquer or synthetic applied on top of this plate will assure the long, tarnish-free life expected from a quality finish.

ECONOMICAL FINISH

In overall economy, the M&T Bronze process does better than gold or brass plating and rivals copper. It can save production time, being able to plate as fast as one-tenth mil in one minute.

EASY TO USE

Since the M&T Bronze Process is as easy to control and to operate as those depositing single metals, it assures consistent results. It can be plated matte as well as mirror-bright, or anywhere in-between. Send for data.

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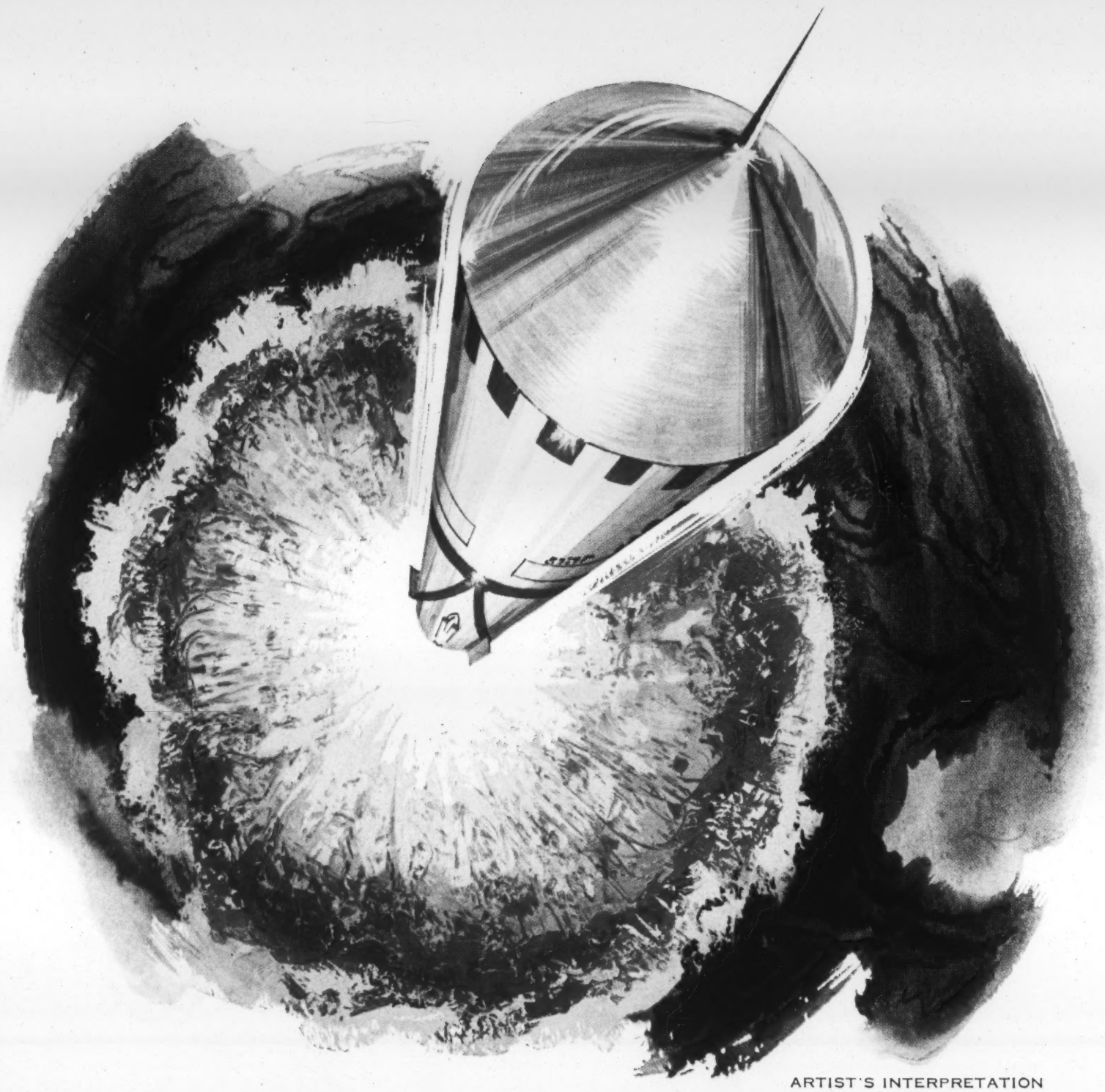


ARTIST'S INTERPRETATION

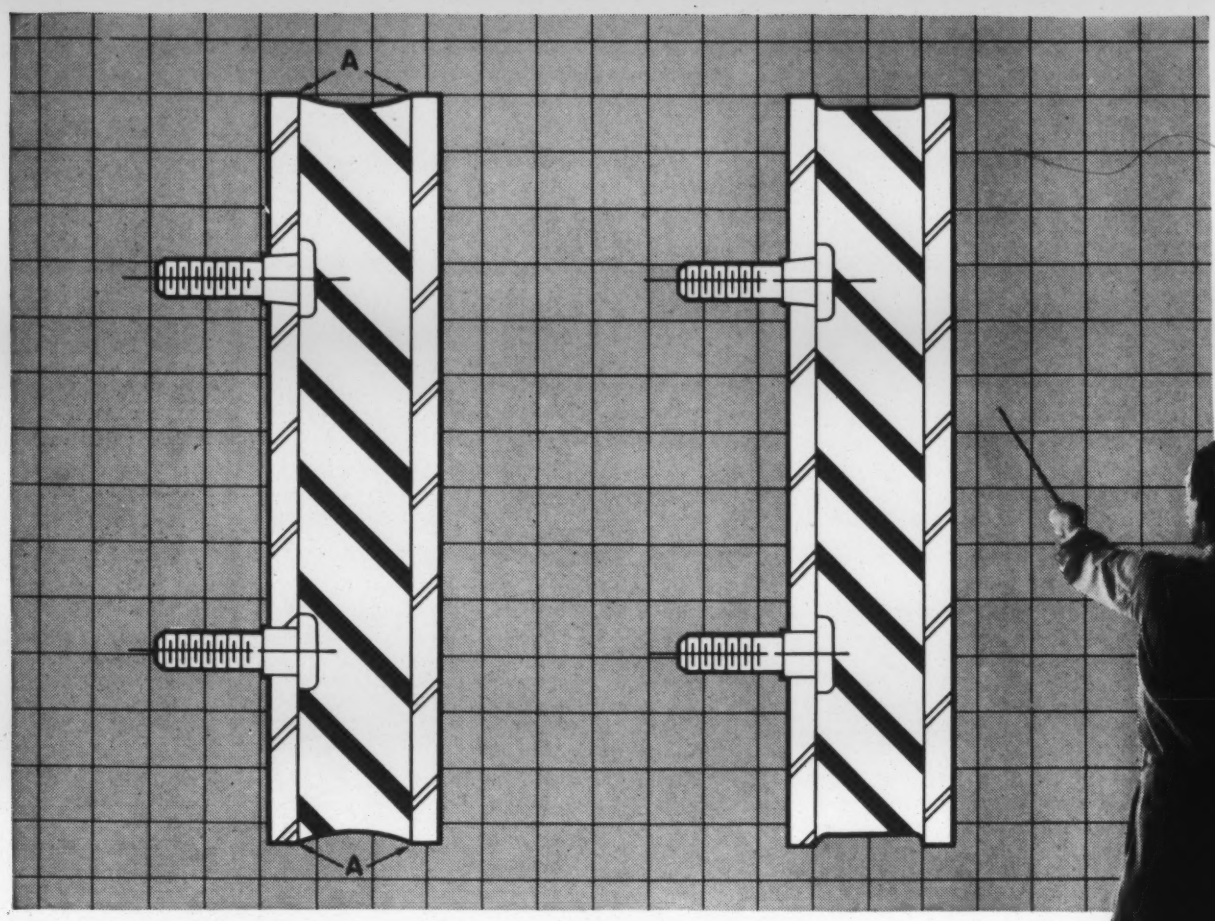
There is no substitute for stainless steel

in outer space

From the intense cold of outer space to the heat of a jet engine, Stainless Steel is the one metal that will stand up. In rockets, missiles and supersonic aircraft, Stainless Steel resists heat, friction and corrosion, has a high strength to weight ratio and maintains its structural integrity under the most severe conditions.

Specify McLouth high quality sheet and strip Stainless Steel. McLouth Steel Corporation, Detroit 17, Michigan.

McLOUTH STAINLESS STEEL



Savings in molded rubber parts begin with improved design

thru **ORCO**

CUSTOMEERING

Similar designs? Almost, but not quite. In the design at left, "A" is a stress point. The shrinkage of the rubber can cause concentrated strain at the edges of the bonded area. Ohio Rubber engineers would probably recommend the design shown at right.

Attention to important details like this is typical of ORCO's "customeering" of parts made from rubber, synthetic rubber, silicone rubber, polyurethane, and flexible vinyl, whether they be molded, extruded, or bonded to metal.

From components weighing less than a gram to parts of over 73 lbs., whatever the shape involved, ORCO's integrated research, design, electronically controlled compound mixing, and production facilities, assure component uniformity and quality to meet the most exacting requirements. Check with ORCO engineers on your next rubber or vinyl component problem. Your inquiry will receive prompt attention.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts".

THE OHIO RUBBER COMPANY

ORCO

A Division of The Eagle-Picher Company
Willoughby, Ohio

EAGLE EP PICHER

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BELL & HOWELL GOT COLOR • TAYLOR INSTRUMENT SAVED $100,000 ANNUALLY • DICTAPHONE REDUCED PRODUCT WEIGHT

WHAT DO YOU WANT IN SCREW MACHINE STOCK?

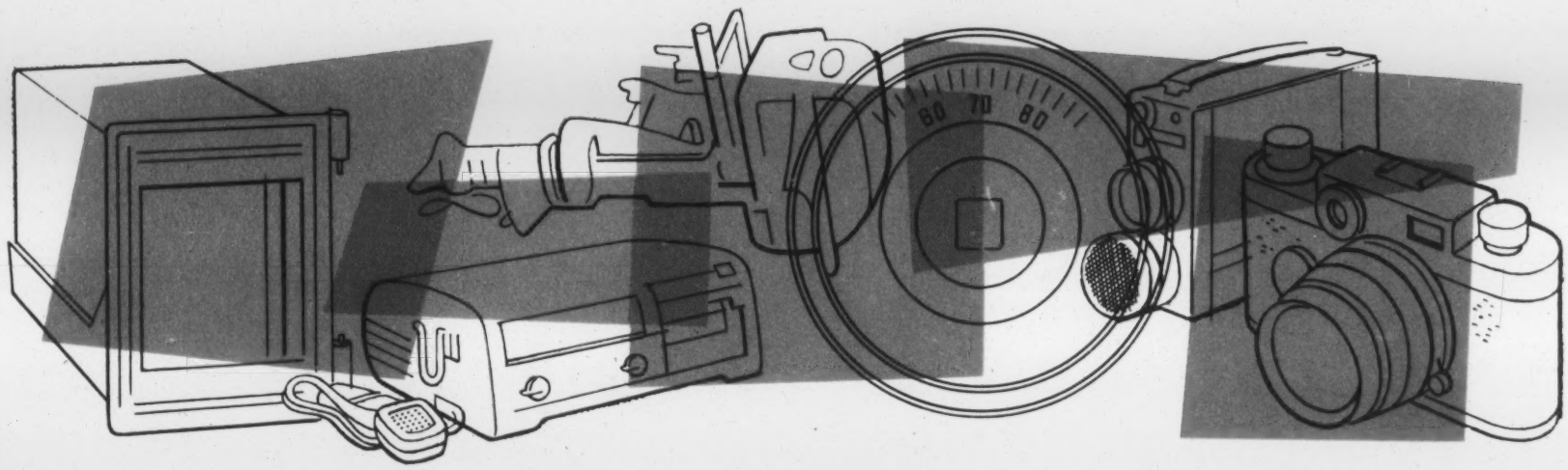
You can get parts in any color with aluminum

The designer today who wants lasting color specifies color anodizing with Alcoa® Aluminum—lustrous color that stays new and fresh because it's part of the metal—color that does not distort dimensions.

Color means eye-appeal for more sales. Would color attract more customers to your product? Bell & Howell asked this question, then switched to gold-anodized aluminum for its new Filmovara zoom projection lens. Now Alcoa Screw Machine Stock adds new beauty to a famous camera and projector line.

Color means eye-appeal for more safety. Does your product have controls where a wrong move means time, expense, accident? Square D's push-button controls electrically operate everything from single machines to assembly lines. They switched to Alcoa Aluminum Screw Machine Stock for colored buttons that are oiltight and metal rugged.

GET DESIGN FREEDOM WITH ALCOA ALUMINUM SCREW MACHINE STOCK



Result: operators now see at a glance what's what, make fewer mistakes.

Color means eye-appeal for better identification. Screw machine parts of Alcoa anodized aluminum are easier to see, stock, inventory and assemble. And color anodizing adds extra protection to aluminum's inherent resistance to corrosion.

You can cut costs with aluminum

You buy screw machine stock by the pound—you machine it by the foot. Alcoa Aluminum gives three times more parts per pound than steel or brass. Aluminum machines faster—cutting speeds as high as 1,000 feet a minute are common. Result: aluminum parts can cost less than steel or brass. It works out this way . . .

. . . aluminum vs steel: machine time makes the difference.

. . . aluminum vs brass: more parts per pound makes the difference.

Here's another way to look at it:

1. Aluminum costs less than brass, machines just as fast.
2. Aluminum machines faster than steel and won't rust.
3. Aluminum scrap allowance is higher than either.

Taylor Instrument Company proved it. By converting 40% of its parts to Alcoa Aluminum Screw Machine Stock, Taylor saved $100,000 annually. And Taylor reports performance equal to or better than other metals.

You can reduce product weight with aluminum

Designers who want less weight specify Alcoa Aluminum. Aluminum weighs less than steel or brass, so the end product weighs less. A switch to Alcoa Aluminum Screw Machine Stock played a major role in reducing the weight of Dictaphone Corporation's Time-Master dictating machine from 20 lbs to 12.4 lbs.

Aluminum weighs less than steel or brass, so it's easier on automatic screw machines and uses less power. Enterprise Manufacturing Company, maker of Pflueger fishing tackle, reports that aluminum gives longer tool life and closer tolerances on drilling, milling, tapping and machining.

Aluminum weighs less than steel or brass, so it's easier to move, stock and handle. Minneapolis-Honeywell reports that its men like aluminum's lightness, especially in the 2⅛" size they use.

Aluminum offers superb machinability

A free-machining metal, aluminum machines as well as free-cutting brass. Aluminum is machined as fast as the machine will run. Dictaphone Corporation reports, "We chase an acme thread in aluminum with two passes, compared to six or seven in stainless."

Aluminum takes any finish

You can polish, buff, brush or burnish aluminum screw machine parts. And the initial fine appearance does not deteriorate—designers no longer need to worry about rusting. Bell & Howell reports that aluminum ensures lasting, maintenance-free color.

Aluminum scrap is worth more

Aluminum scrap brings more per pound than either steel or brass. Argus Cameras, Inc., reports that many of its parts require 75% stock removal. "Aluminum's high machinability and high scrap value help us greatly."

WHAT DOES ALL THIS MEAN TO THE DESIGNER?

Aluminum provides optimum design freedom. Aluminum gives exceptional machinability—limited almost entirely by machine capacity; high electrical and thermal conductivity; choice of any finish—or color; always less weight and frequently lower in cost than steel or brass. Summation: fewer restrictions on the designer.

For more about conversion to Alcoa Aluminum Screw Machine Stock, call your nearest Alcoa sales office. For prompt delivery of Alcoa Aluminum Screw Machine Stock, contact your local Alcoa distributor. Send for Alcoa's new booklets about aluminum screw machine stock. They contain direct quotes from design engineers, production engineers and purchasing agents of leading industries on why they switched to Alcoa Aluminum. ALUMINUM COMPANY OF AMERICA, 869-F Alcoa Building, Pittsburgh 19, Pa.

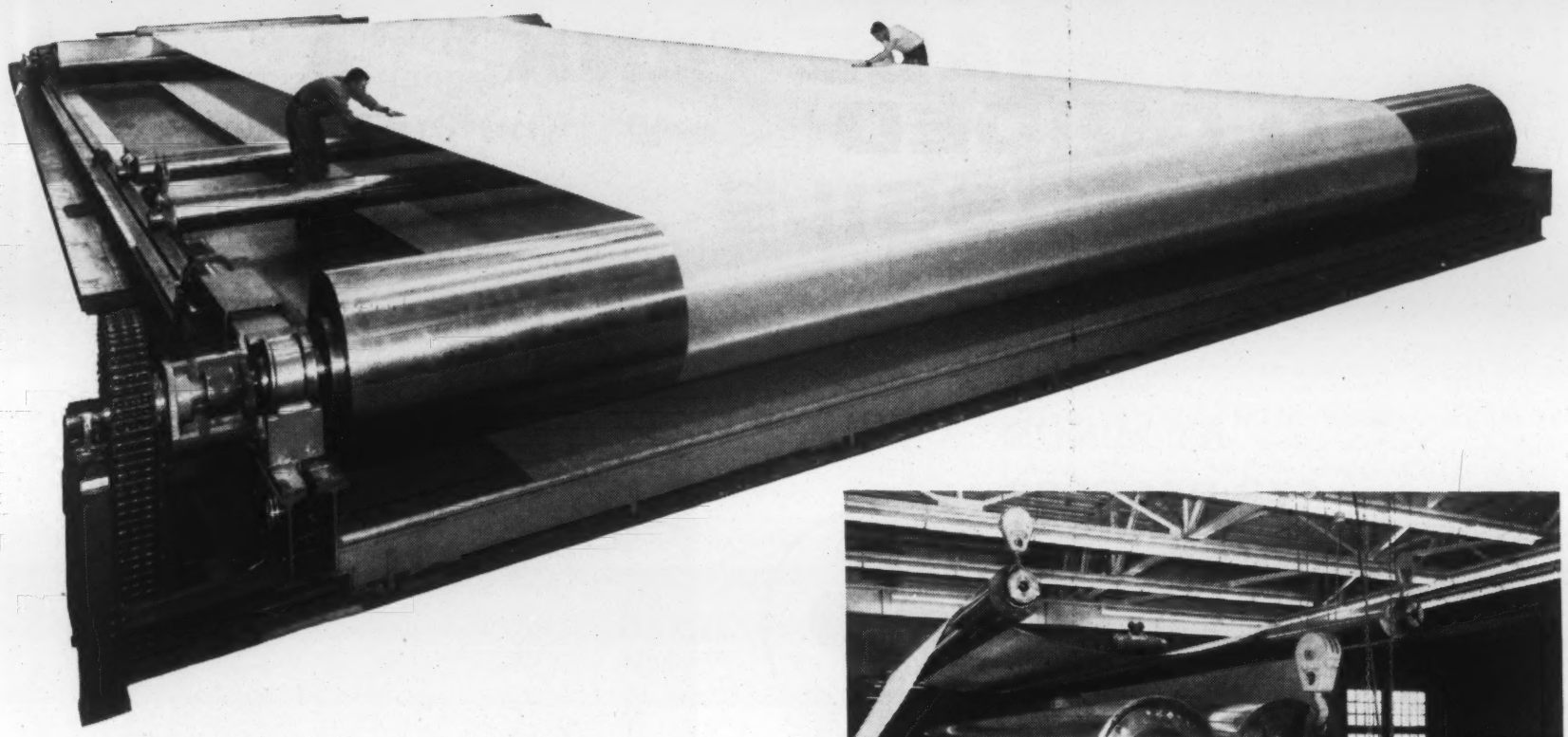
"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

Look for this label... it's your guide to the best in aluminum value

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

In specialized applications...

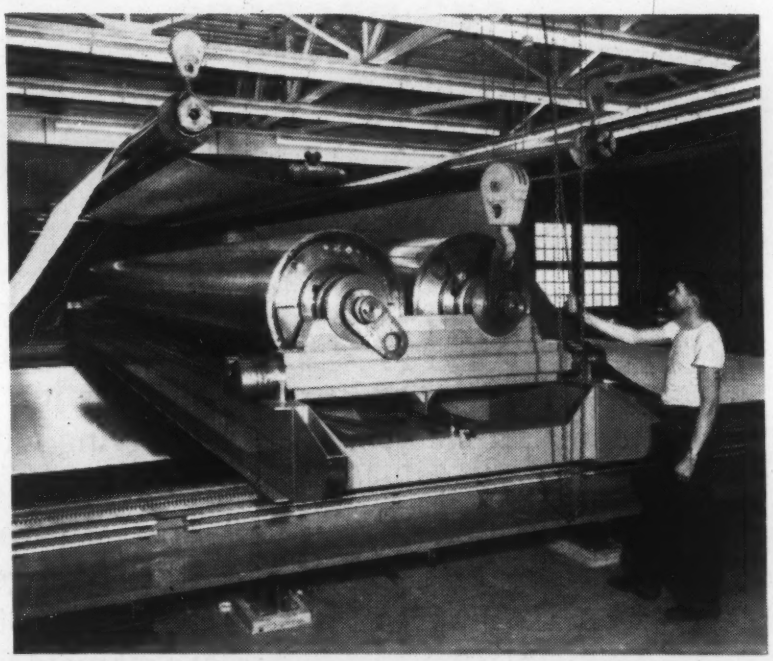
ACIPCO *CENTRIFUGALLY SPUN* STEEL TUBES



Appleton Wire Works, Inc., manufactures high quality fourdrinier wires for paper making machines. These fine-mesh wires are woven in widths up to 340 inches and lengths over 180 feet.

At its Montgomery, Alabama, plant, Appleton Wire Works, Inc. uses ACIPCO steel tubes— centrifugally spun and polished at Acipco—as stretch rolls on the huge finishing table. These 35.625″ OD, 410″ long rolls must be both dimensionally stable and balanced and must have a polished surface which will not affect the delicate woven wire surface mechanically or chemically.

Here is another example of Acipco versatility. If your application requires heavy wall steel or alloy iron tubes with special physical, chemical or metallurgical properties "built-in," Acipco can serve you. Investigate Acipco's complete "one source—from start to finish" facilities. A call or letter will bring full information on Acipco centrifugally spun tube applications in your field.



VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

Size Range: Lengths up to 410″ to meet modern machinery requirements have been produced. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

Analyses: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special non-standard analyses.

Furnished: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

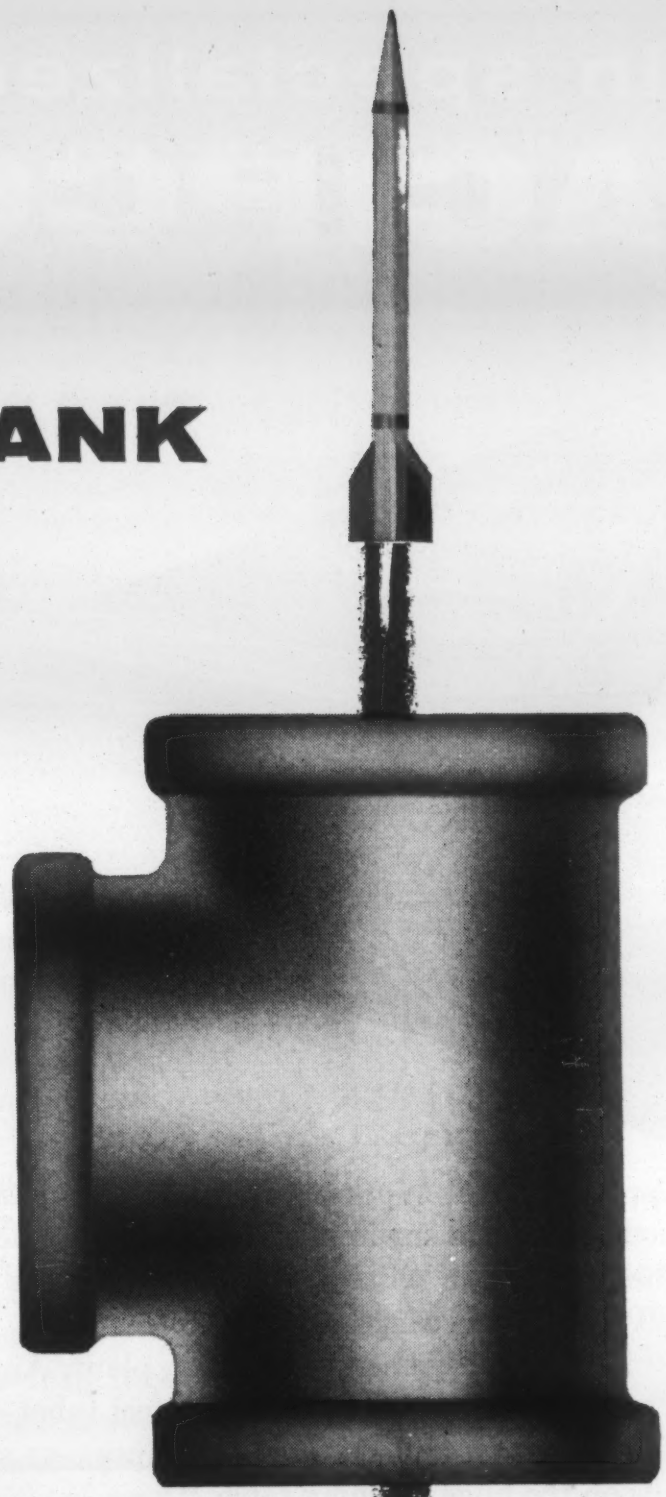
SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

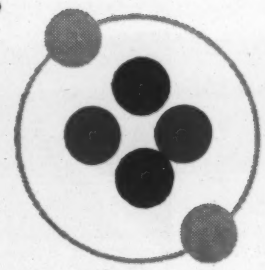
BIRMINGHAM 2, ALABAMA

For more information, turn to Reader Service card, circle No. 446

FROM STORAGE TANK TO GUIDED MISSILE



AT MINUS 452 DEGREES



Transferring corrosive fuel from storage tanks to missiles at pressures over 10,000 psi and at temperatures as low as —452°, is just one of many problems *ESCO* is resolving with special heavy wall stainless steel fittings.

ESCO can help you with special fittings requirements, or meet your other fittings needs from stock, with 150 lb. heavy wall cast stainless steel screwed fittings, socket weld fittings, flanges, flanged fittings and Schedule 40 welding fittings.

ESCO testing and research laboratories are equipped to tailor stainless steel alloys to the most exacting requirements. Rigid control of more than 95 steel alloys is maintained and metallurgical research is on a continuously active basis.

Call your nearest ESCO representative for details today.

ESCO®

ELECTRIC STEEL FOUNDRY COMPANY

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MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.

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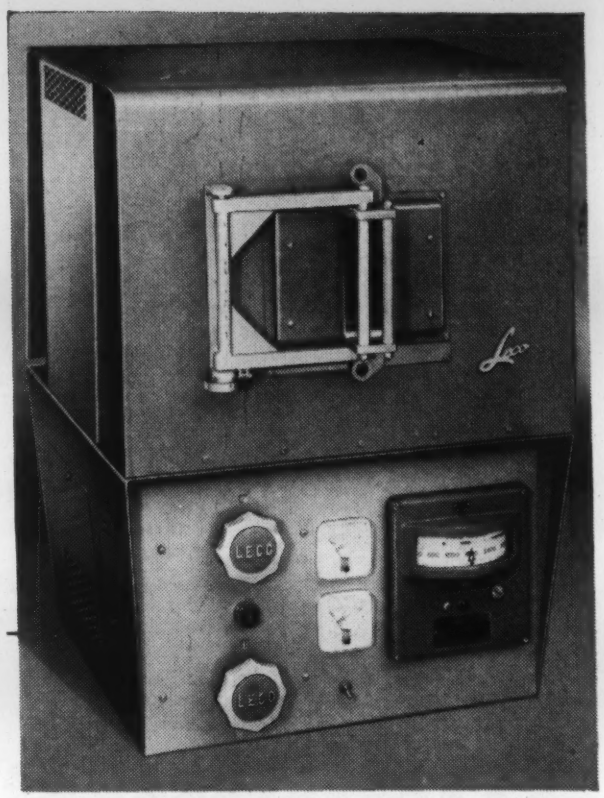
IN CANADA ESCO LIMITED

For more information, turn to Reader Service card, circle No. 421

Leco designs new furnaces around Norton "HOT RODS"

Leading lab furnace builder reports longer life and other advantages of CRYSTOLON heating elements*



The new LECO Model 542 Box Furnace — equipped with long-life CRYSTOLON heating elements — is shown above. Other new Hot Rod-equipped LECO furnaces include two tube and four tube models.

LECO Laboratory Equipment Corporation
Manufacturers of Precision Control Equipment
St. Joseph, Michigan

January 15, 1958

Norton Company
Worcester 6, Massachusetts
Attention: Mr. W. H. Davenport
Refractories Sales Engineering Dept.

Gentlemen:

At LECO we have been so impressed by the advantages of CRYSTOLON heating elements that we have designed our complete new line of resistance furnaces around them.

When these new furnaces were exhibited at recent trade shows, they created an overwhelming amount of interest. Our customers and prospects were particularly impressed by the fact that two years of field tests revealed that CRYSTOLON elements have far superior life to ordinary elements.

As you know, the way for a firm to advance is to bring progress to its customers, and we really feel we are bringing the latest in technological advances to our customers with Norton Hot Rods.

Very truly yours,
LABORATORY EQUIPMENT CORPORATION

H. J. Schmitt

H. J. Schmitt
General Sales Manager

HJS: rm
Enc.

CRYSTOLON Heating Elements, or "Hot Rods", are a typical Norton Rx — an expertly engineered refractory prescription for greater efficiency and economy in electric furnace and kiln operations. Made of self-bonded silicon carbide, each one-piece rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes.

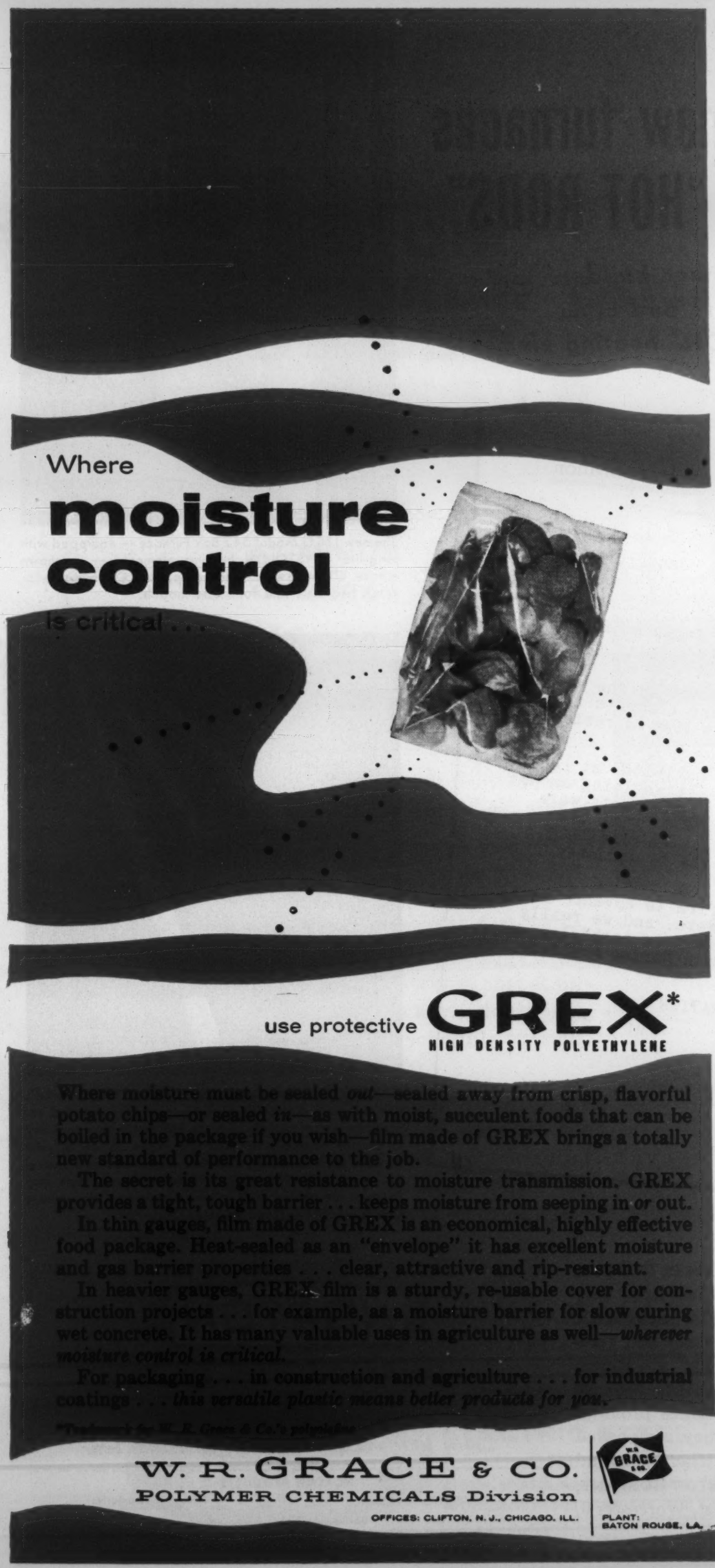
Similar reports from many other plants mean that you, too, can save with "Hot Rods" because their extra long life greatly reduces replacements. Also, you get reduced maintenance due to less changing of elements and voltage taps. One-piece, non-welded "Hot Rods" are strong and straight . . . help protect product quality because their slow, evenly matched rate of resistance provides more uniform heating quality . . . and they are packed shockproof to reach you unbroken. For further facts send for booklet *Norton Heating Elements*. NORTON COMPANY, Refractories Division, 345 New Bond Street, Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered . . . Rx . . . Prescribed
Making better products . . . to make your products better

NORTON PRODUCTS
Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING DIVISION
Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more information, turn to Reader Service card, circle No. 370



GREX* in action

Unlimited Applications

To preserve perishables, control moisture, and retain *all* the flavor in frozen food packages, GREX shows the greatest promise in protective packaging today.

In sheet form for rigid vacuum formed containers, or in thin films for packaging . . . overwraps, paper coatings, heat-sealed bags, and drum liners are a few possibilities that instantly spring to mind . . . you can expect exceptional quality when you make it with GREX. Its glossy rich finish gives your package additional sales appeal.

Tough, Adaptable

Clear or *frosted*, GREX film is *easily imprinted.* Above all, GREX is *tough* . . . its high density molecular structure forms an almost *impenetrable* moisture barrier even when the *gauge of the film is thin* or in containers with *eggshell thin* side-walls.

Moreover, this superior moisture barrier retains its effectiveness over an extremely wide range of temperatures. This immediately forecasts a brilliant future for transparent packaging of foods stored in the deep freeze until ready to be cooked . . . *in the bag* . . . in boiling water. The packager concerned with *containing the flavor* is going to be looking to GREX.

In brief, if moisture barriers are important in your packaging, we'd suggest that you investigate the use of GREX. You may find that it is *more economical* than your present packaging material.

Other Fields

The fields of agriculture and construction look to GREX for a better future, too. On the farm, silage, mulching, and pond liners are ideal GREX applications. In construction, GREX will provide more effective moisture control under slab foundations and roads.

For More Information . . .

We have the facilities, the people, the production capacity, *and the interest* to help you investigate the potentials offered by GREX high density polyethylene in *any* of these applications. For further information, write to W. R. Grace & Company, Polymer Chemicals Division, 225 Allwood Road, Clifton, New Jersey; or 3555 West Peterson Avenue, Chicago, Ill.

For more information, turn to Reader Service card, circle No. 484

A REVOLUTION IN RARE EARTHS

Costs down sharply... large quantities available

a report by LINDSAY

Today you can buy at $50 per pound Samarium Oxide of 99% purity which in 1955 cost $1825—a price reduction of 97%, almost unprecedented in the chemical industry.

All high purity rare earths are priced substantially below the 1955 levels. Price ranges for four oxides, over a three-year period, are shown in the graphs.

During 1954, there was a rapidly developing industrial interest in high purity rare earths which were available then only in small, laboratory-production quantities and at very high prices.

In 1955, Lindsay pioneered the first commercially installed ion exchange pilot plant with 40 six-inch columns for the production of rare earth oxides in purities up to 99.99%. As these materials became available, the response from industry demonstrated that much larger production facilities were urgently needed.

LINDSAY EXPANDED PRODUCTION

Consequently Lindsay immediately expanded its ion exchange plant and is now operating continuously more than 100 columns with large production units of eighteen-inch and sixty-inch diameters.

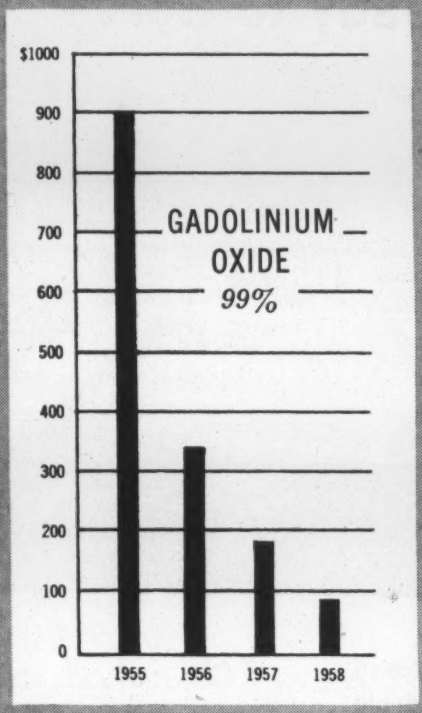
With large volume production, we can now make prompt shipments of high purity materials in quantities from a gram to hundreds of pounds.

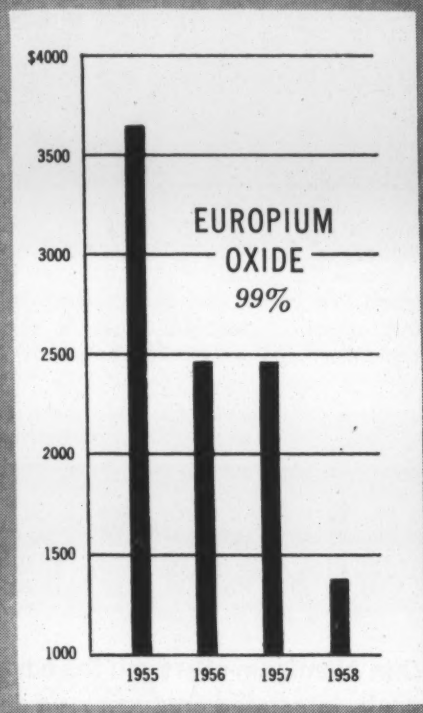
Current prices make high purity rare earths extremely attractive and economically sound for a wide variety of chemical and industrial purposes.

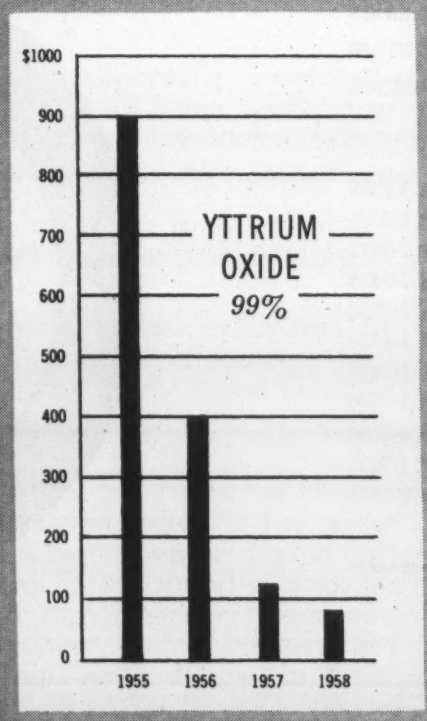
We will be happy to supply technical data and information about availabilities, prices and industrial applications.

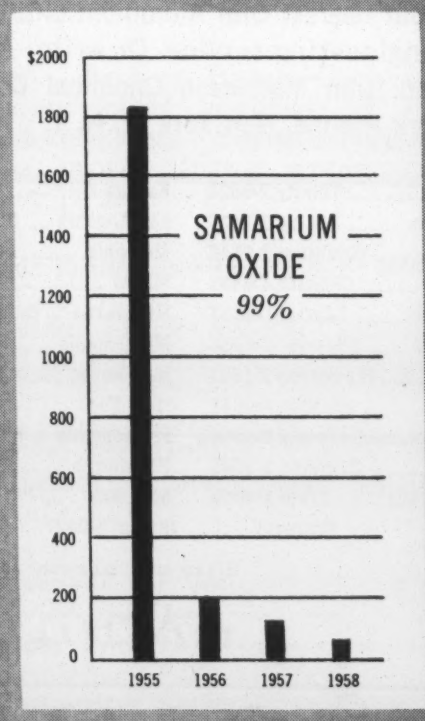
THREE YEAR DECREASE IN SELLING PRICE

in dollars per pound









PLEASE ADDRESS INQUIRIES TO:

LINDSAY CHEMICAL COMPANY

World's Largest Producer of Thorium and Rare Earth Chemicals

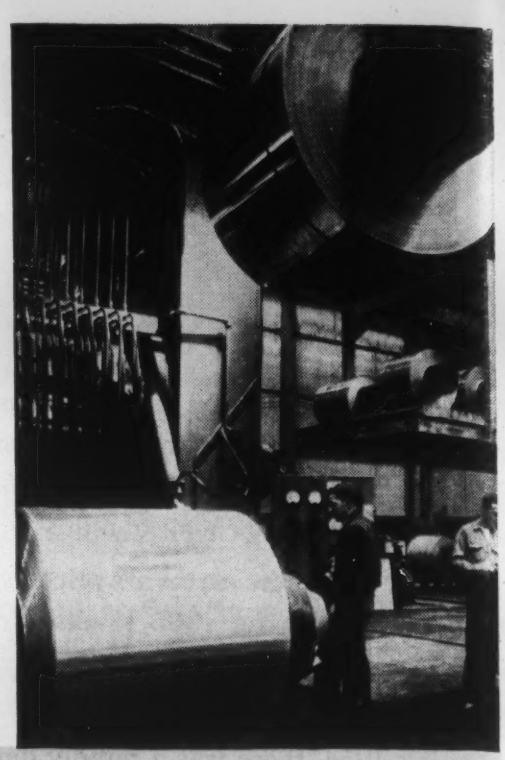
276 ANN STREET • WEST CHICAGO, ILLINOIS

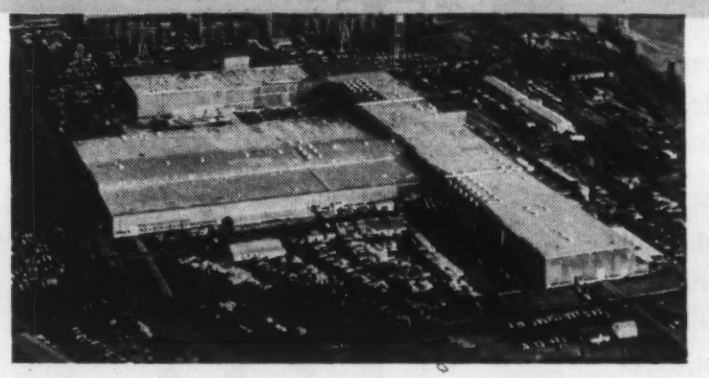
For more information, turn to Reader Service card, circle No. 380

Olin Aluminum

pig...ingot...billet...flat sheet...
coiled sheet...fin stock...plate...
extrusions...solid...hollow...
semi-hollow...pipe and tubing...
rod and bar...electrical conductor...

is ready to Serve





Now Olin Aluminum offers you the advantages of a large scale, integrated producer . . . a dependable source for your growing need for fine aluminum. Call your nearest Olin Aluminum office for sales and engineering service. Or write: Aluminum Division, Olin Mathieson Chemical Corporation, 400 Park Avenue, New York 22, N. Y.

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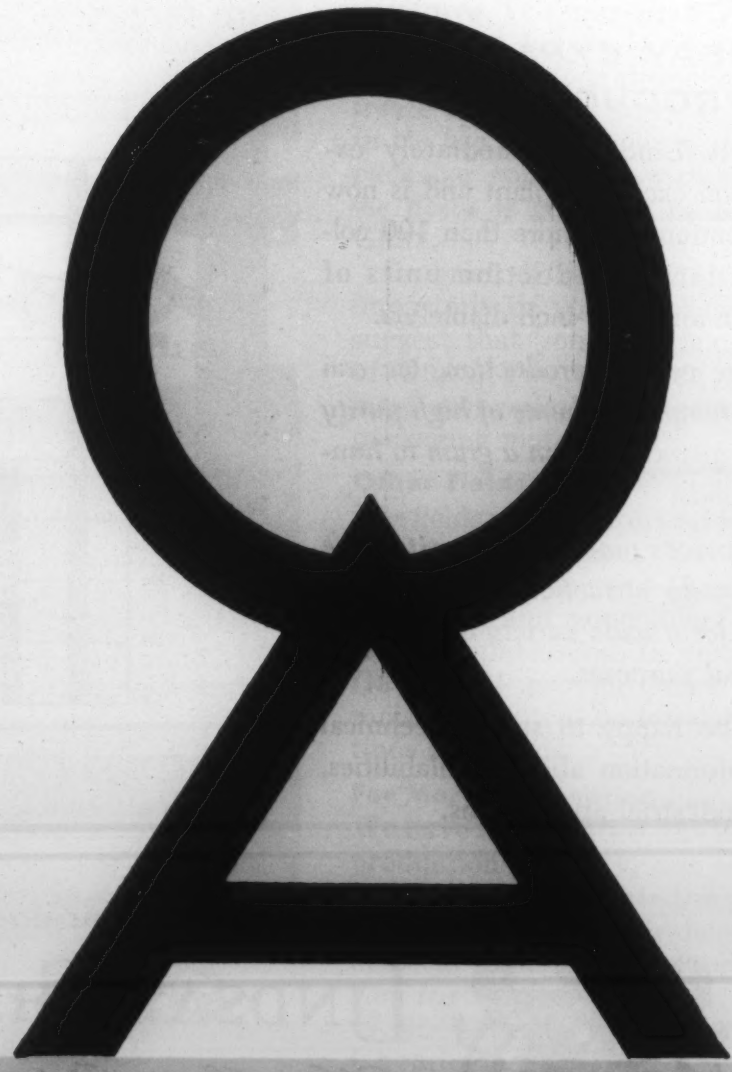
® AND "OLIN ALUMINUM" ARE TRADEMARKS

OLIN MATHIESON CHEMICAL CORPORATION

OLIN ALUMINUM



Symbol of Quality and Service in the Aluminum Industry

For more information, turn to Reader Service card, circle No. 546

A Leading Manufacturer Reports —

"Among the materials tested for our use, Spencer Nylon 401 proved the best from the standpoint of toughness," says Byron Carlson (right), assistant chief engineer at Scott-Atwater. Unique materials problem solved by Spencer Nylon is discussed above by Mr. Carlson and John Beavens (left) of Scott-Atwater, and Cliff Hutchison, president, Molding Jobbers, Inc.

Nylon Solved Our Design Problem

. . . and Spencer Nylon 401 proved best in an application requiring extreme toughness."

A materials crisis was solved recently when Scott-Atwater and Molding Jobbers, Inc. of Minneapolis took advantage of the special benefits available in new Spencer Nylon.

The story began when Scott-Atwater, makers of outboard motors, designed a new type of gear box involving a remote control gear sector. Scott-Atwater engineers first tried metal gears in their tests and found them unsatisfactory. Then Molding Jobbers, Inc. suggested the use of nylon gears. The nylon gears had many advantages over metal:

1. **Less cost** — nylon is at least 20% cheaper than cast aluminum in this application.

2. **More efficient** — nylon is essentially self-lubricating.

3. **Fewer alignment problems**— nylon deforms 75 times easier than steel, enough to overcome minor inaccuracies.

4. **No corrosion problem**—nylon has superior chemical resistance.

An unusually tough nylon was required in the Scott-Atwater gear sector. Two gears were involved and both were subjected to considerable stress.

The first nylon tested failed under tension. Then Spencer Nylon 401 was tested. It was found in a torque load test that Spencer Nylon was much stronger. In fact, Spencer 401 ran as high as 90 ft. lbs. in a test requiring 55 to 60 ft. lbs. Spencer Nylon also proved best in tensile strength and brittleness (impact test). And as Byron Carlson, assistant chief engineer at Scott-Atwater, says, "Spencer Nylon 401 has proved highly consistent in gear performance."

This is just one example of the versatility of Spencer Nylon. Spencer Nylon offers special advantages not only for injection moldings, but also for extruded items such as pipe and film. And many processors are finding Spencer Nylon superior for items made by centrifugal casting and extrusion molding.

Discover for yourself how Spencer Nylon can help cut your material costs and help you solve design problems. For complete information write: Spencer Nylon, Spencer Chemical Company, 700 Dwight Bldg., Kansas City 5, Mo.

NOW! NYLON *by* SPENCER

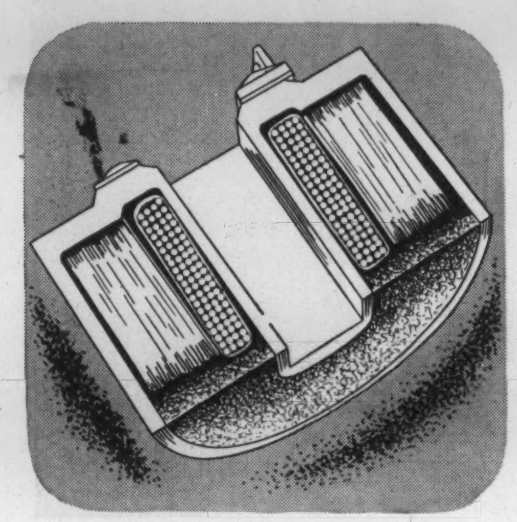
SPENCER

SPENCER CHEMICAL COMPANY

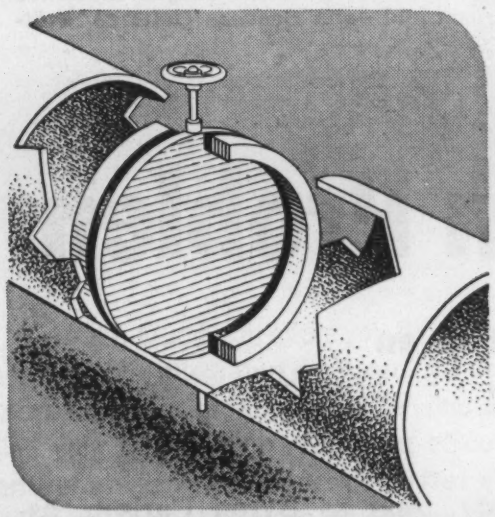
GENERAL OFFICES: DWIGHT BUILDING, KANSAS CITY 5, MISSOURI

For more information, turn to Reader Service card, circle No. 428

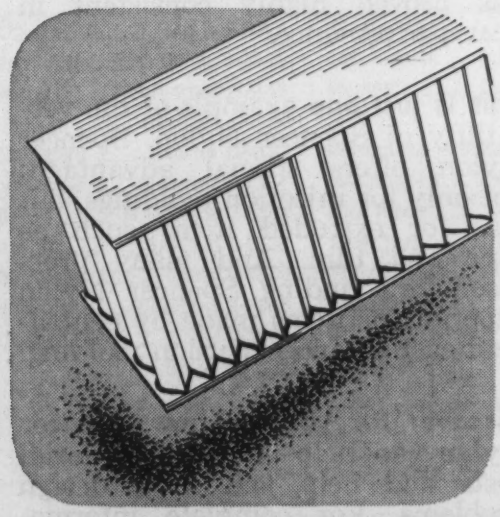
Tailored R/M *Ray-BOND*® Adhesives speed and simplify your production, cut your costs



Sealing hundreds of wires with an R/M encapsulating compound.



Bonding rubber seals to rotating water gate valves.



Resin-treated paper bonded to metal saves weight in this honeycomb.

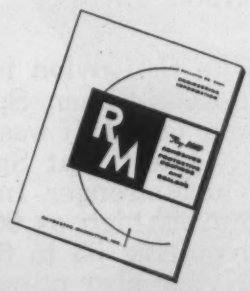
For these and 1001 other applications, new R/M Ray-BOND adhesives can be tailored to your needs

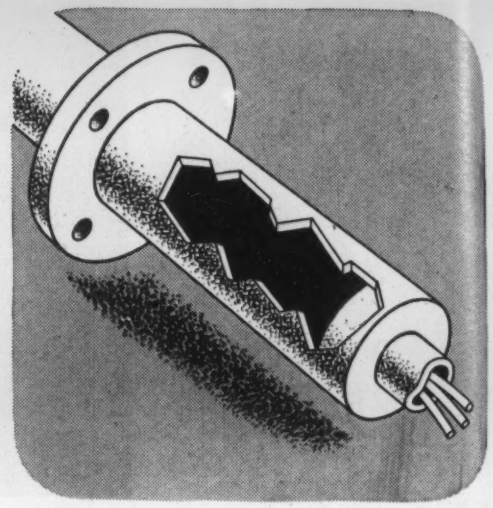
Adhesive bonding offers you many advantages. Because it eliminates rivets and other fasteners, your production costs are reduced and many assemblies otherwise difficult or impossible can be done with ease. With Ray-BOND adhesives, you can join dissimilar materials. Where unusually high or low temperatures constitute a problem, adhesive bonding frequently furnishes the ideal solution. It provides better heat conductivity, seals gaps and voids in metal products, and increases the life of friction members.

Ray-BOND Adhesives have proved themselves in a great variety of applications, and on products ranging from sewer pipes to snow trains, from ribbons to tool tips, from submarines to aircraft. They have been chosen because they resist temperatures as low as –80°F or as high as 700°F.

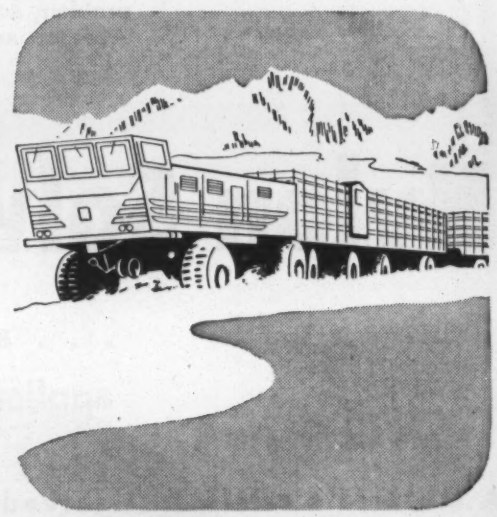
Raybestos-Manhattan offers you the benefit of more than 20 years of experience and pioneering in the production of bonded assemblies and the manufacture of adhesives and coatings. Feel free to call on R/M engineers for their help.

Write now for your free copy of R/M Bulletin 700, containing engineering information on Ray-BOND adhesives, protective coatings and sealers.

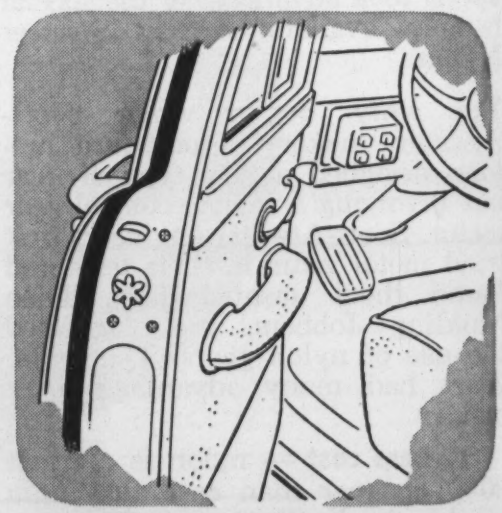




Bonding vinyl jacket and steel gland in cable —protecting against moisture and corrosion.



Bonding brake linings for sub-zero operation in snow train.



Making weatherproof bond between sealer strip and car door.

RAYBESTOS-MANHATTAN, INC.

ADHESIVES DEPARTMENT: Bridgeport, Conn.

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FACTORIES: Bridgeport, Conn.; Manheim, Pa.; Passaic, N.J.; No. Charleston, S.C.; Crawfordsville, Ind.; Neenah, Wis.; Paramount, Calif.
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RAYBESTOS-MANHATTAN, INC., Industrial Adhesives • Brake Linings • Brake Blocks • Clutch Facings • Industrial Rubber • Engineered Plastics • Sintered Metal Products
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For more information, circle No. 478 ➤

Better Tools...

BEGIN WITH

SHARON QUALITY

ALLOY STEELS

What's new in the way of garden tools? This tool caddy, for one thing, and Sharon metallurgists know all about it.

Sharon has been supplying carbon, stainless and special alloy steels to garden and farm implement manufacturers for more than 50 years and they know the industry and its requirements.

So, if you're in the business of farm and garden tools, isn't it just good business to become acquainted with . . .Sharon Quality Steels?

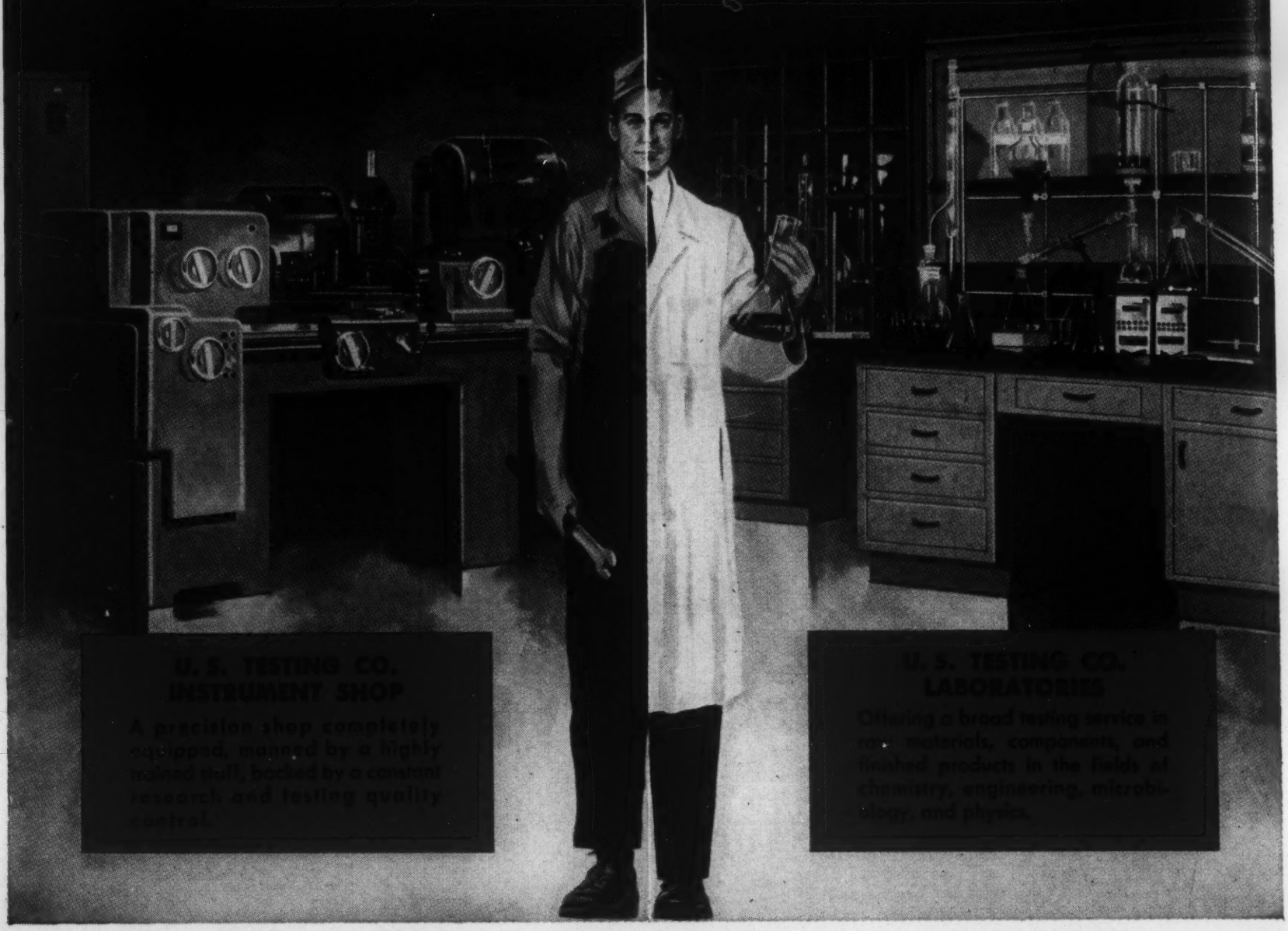
SHARONSTEEL

SHARON STEEL CORP.

SHARON, PENNSYLVANIA

Scientific TESTING INSTRUMENTS

MADE BY A FUNCTIONING LABORATORY

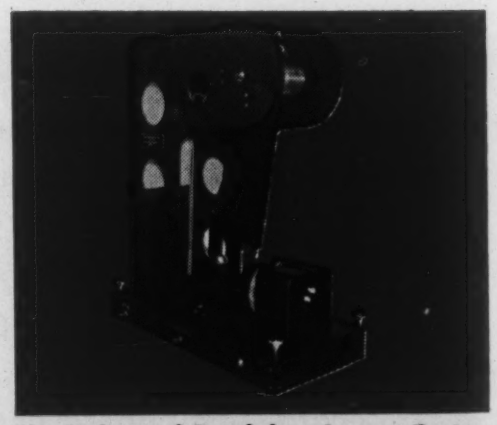


WE MAKE THEM MORE EFFICIENT...BECAUSE WE USE THEM, TOO!

As the only functioning laboratory manufacturing instruments, we are able to harness the talents of the laboratory technician and the instrument technician. Result: the instruments are conventional in operation, simple to calibrate, easy to maintain. They are sensitive, stable, and, in most cases, applicable to multi-purpose testing requirements. And all are, of course, pre-tested in practical performance problems in our own laboratories before they are put on the market.

Our instrument service is four-fold: we design and manufacture new instruments for firms, trade associations, scientific societies, and governmental agencies; we modify existing instruments to meet special needs; we manufacture instruments from existing designs; we operate new instruments where impartial laboratory reports are essential.

Be sure to write for our informative Instrument Service Bulletins, mailed free at regular intervals.



The Universal Pendulum Impact Tester with interchangeable striking heads and weights is broadly applicable to tests on paper, plastics, textiles, rubber, etc., in sheets, foams and solid shapes.

UNITED STATES TESTING COMPANY, INC.

Established 1880

1600 PARK AVENUE, HOBOKEN, NEW JERSEY

Boston • Brownsville • Dallas • Denver • Los Angeles • Memphis • New York • Philadelphia • Providence • San Angelo

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P&H

welding positioner saves 90 hours in welding time

The P&H WP-80 — world's largest power-elevating positioner — is the only welding positioner made that can power-elevate 40-ton weldments.

Savings come big when you use P&H welding positioners in your welding operations. Here's proof — the results obtained by using a P&H WP-80 positioner in welding the power-shovel frame shown above:

The weldment is 12 ft. wide, 35 ft. long, 3½ ft. high, and weighs 59,000 lbs.

Downhand welding permitted depositing much heavier first-run beads, thus eliminating stringer beads. The number of passes in most cases dropped from three to one. The result: *a cut of 90 hours in welding time alone!* And the number of crane lifts was slashed from 32 to 9.

With the WP-80, work interruptions dropped sharply — safety was greatly improved. That's because, once the piece is secured on the positioner, the operator can position it at any angle quickly and easily by remote control.

P&H offers you a complete line of welding positioners in capacities from 500 to 100,000 lbs. — with variable speed, if you desire. For more facts, get a copy of "What you should know about welding positioners." Write to Dept. 309G, Harnischfeger Corporation, Milwaukee 46, Wisconsin.

HARNISCHFEGER

P&H WELDERS • ELECTRODES • POSITIONERS

For more information, turn to Reader Service card, circle No. 377

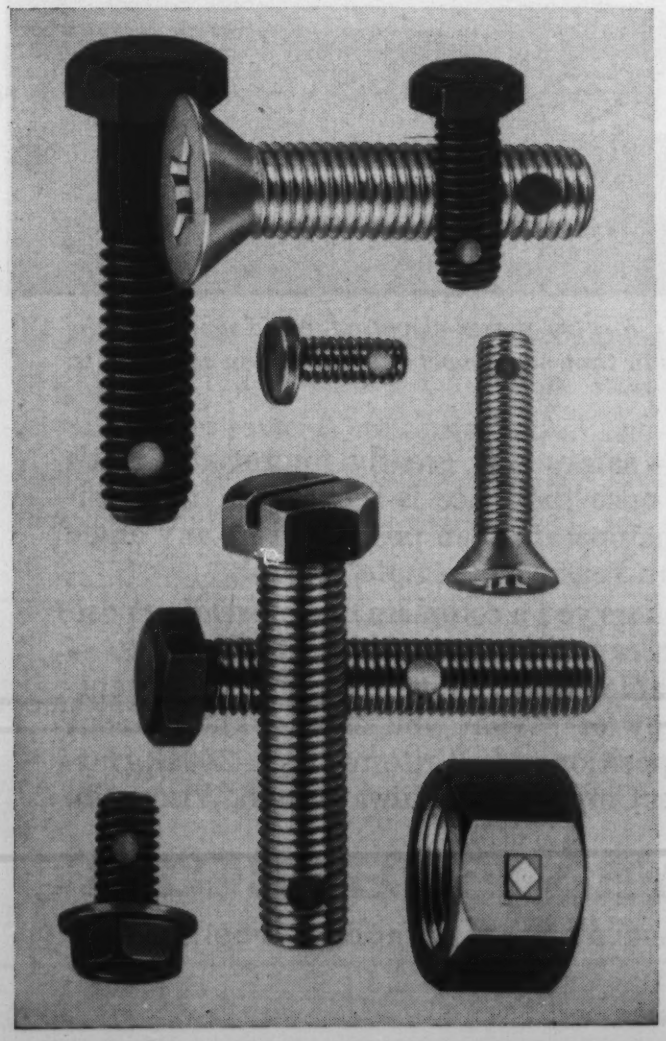
"We've built a better mouse trap with REPUBLIC ELECTRO PAINTLOK SHEETS"

"If we expected the world to beat a path to our door," continues Mr. Coughanor, "we knew every detail of design and material in the Self Sett Trap had to be exactly right. As a result, extensive tests have been conducted which prove design efficiency. And experience has proved Republic Electro Paintlok is the best steel sheet we can buy for economy, long life, and excellent paint-holding qualities. The combination of these factors gives us the best, safest, most foolproof product on the market."

This enthusiasm for Republic Electro Paintlok® is echoed by many other product manufacturers faced with a wide range of forming and application problems. The reason is the chemically treated zinc surface of Republic Electro Paintlok which leaves the mill in prime condition for painting, and won't crack, flake, or peel under any forming operation permitted by the base metal.

These features of Electro Paintlok protect the applied finish of completed products—holding it tightly and restricting corrosion to the point of damage if it should be scratched through.

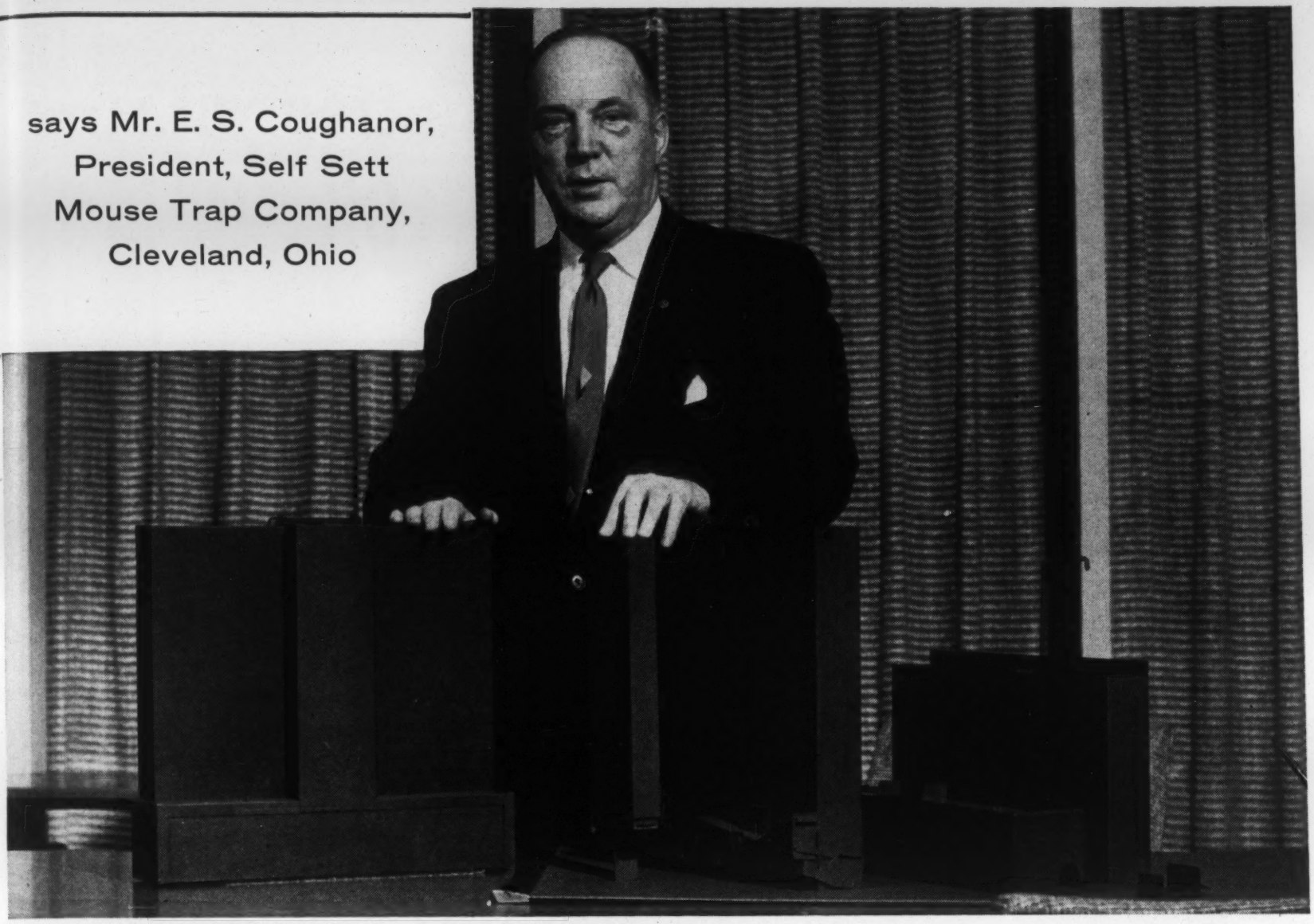
If you want to "build a better mouse trap" in your product field, it will pay you to get all the facts on versatile Republic Electro Paintlok. Contact your Republic representative or mail coupon.



BETTER OVER-ALL PERFORMANCE WAS MADE POSSIBLE through the use of Republic Titanium in the manufacture of these hemispheres by Alloy Products Corporation, Waukesha, Wisconsin. Used for special aeronautical applications, completed spheres provide light weight without impairing safety; strength to contain 2,000 p.s.i.; extreme corrosion resistance to chemically active contents. Beyond providing product advantages, Republic Titanium is easy to draw, pierce, and weld. Little change in fabricating procedure is required as compared with other construction materials. Send coupon for data.

BETTER SERVICE FROM BOLTED ASSEMBLIES subject to impact and vibration can be secured when they are fastened with Republic Nylok® Bolts and Nuts. The resilient nylon pellet imbedded in the body of bolt or nut forces a tight metal-to-metal lock between opposite mating threads. Pellet is unaffected by age or moisture and permits both adjustment and re-use without loss of holding power. Lock is secure even if fastener is not seated. For details, send coupon.

says Mr. E. S. Coughanor,
President, Self Sett
Mouse Trap Company,
Cleveland, Ohio



OPERATION OF THE SELF SETT MOUSE TRAP, as indicated here by Mr. Coughanor, depends on both ingenious design and corrosion resistant materials. A series of automatic doors and pivoted ramps leads the rodent to his destruction in a tank of water. The special coating on Republic Electro Paintlok holds painted finish securely to provide long-term corrosion resistance required to maintain trap operating efficiency.

BETTER COAL "FINE" RECOVERY RATE WAS SECURED when the cotton fabric on this coal-cleaning plant disc-type filter was replaced with a finely woven mesh of Republic ENDURO® Stainless Steel. In addition to doubling efficiency, ENDURO provides far longer service. Republic ENDURO is available in all standard forms, finishes, and analyses. For full information, mail coupon.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

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1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on:

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☐ ENDURO Stainless Steel ☐ Nylok Fasteners

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

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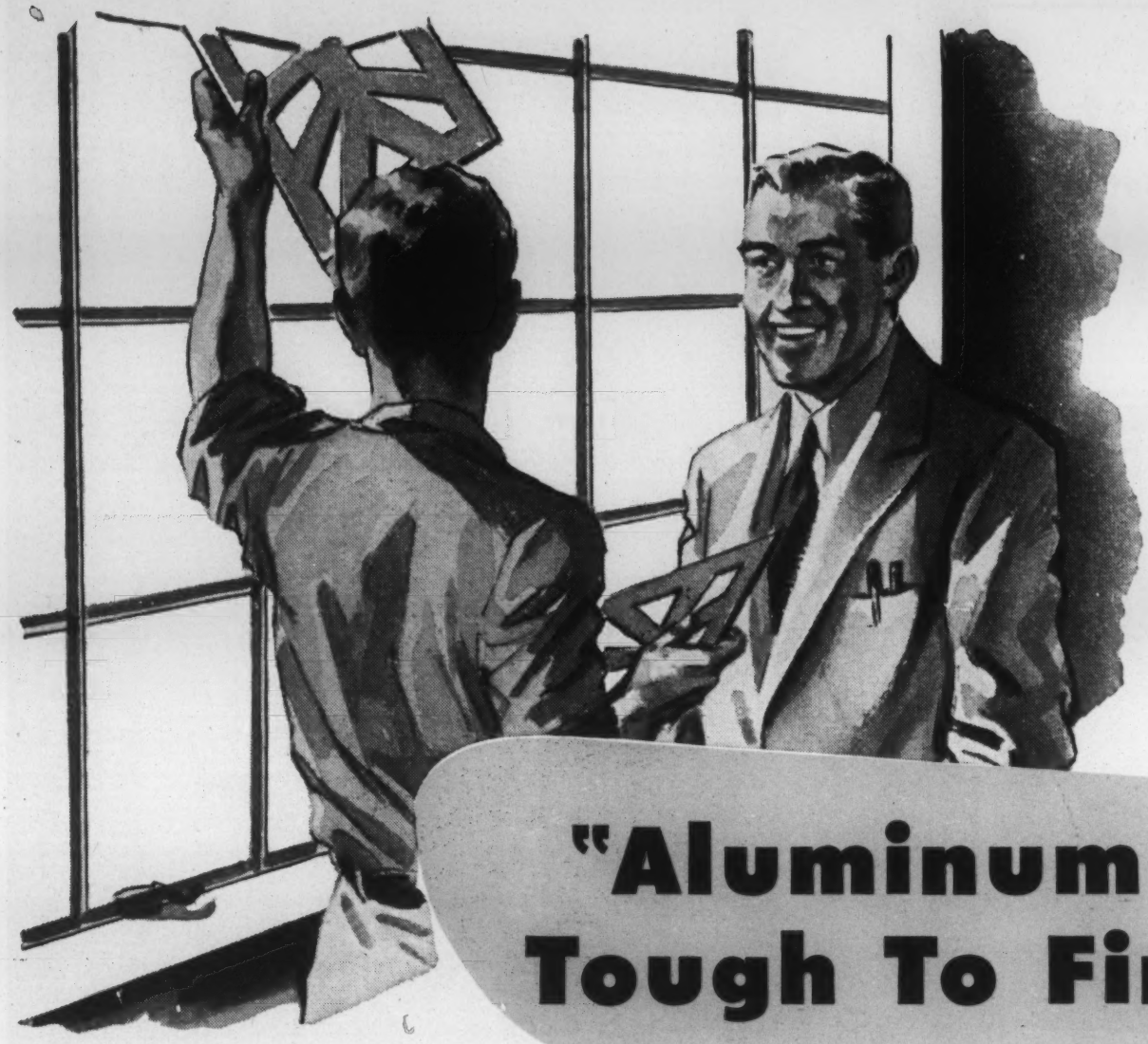

"Aluminum WAS Tough To Finish...

. . . before Northwest developed these SPECIAL ALUMINUM CHEMICALS."

If you work with aluminum you'll be interested in Northwest's outstanding line of chemicals for use with modern alloys. Northwest's continuing research and development program has earned them the reputation of "First with the best" in this rapidly developing field. It will pay you to investigate:

Got a Problem?
Let our Cleaning Specialists help you!

- **ALKALUME CLEANERS**—A full line of cleaners and etching compounds especially formulated for use on aluminum alloys prior to plating, anodizing, painting or welding.
- **ALKALUME PRE-PLATE**—An especially effective zincate bath for preparing aluminum for plating.
- **ACID SOLVENT EMULSION CLEANER No. 1**—An effective cleaner for fabricated aluminum parts before finishing.
- **DRAWING AND STAMPING COMPOUNDS FOR ALUMINUM**

NORTHWEST CHEMICAL PRODUCTS are manufactured on the West Coast by—

ALERT SUPPLY COMPANY
2041 South Davie • Los Angeles 22, California

NORTHWEST CHEMICAL CO.

9310 ROSELAWN DETROIT 4, MICH.

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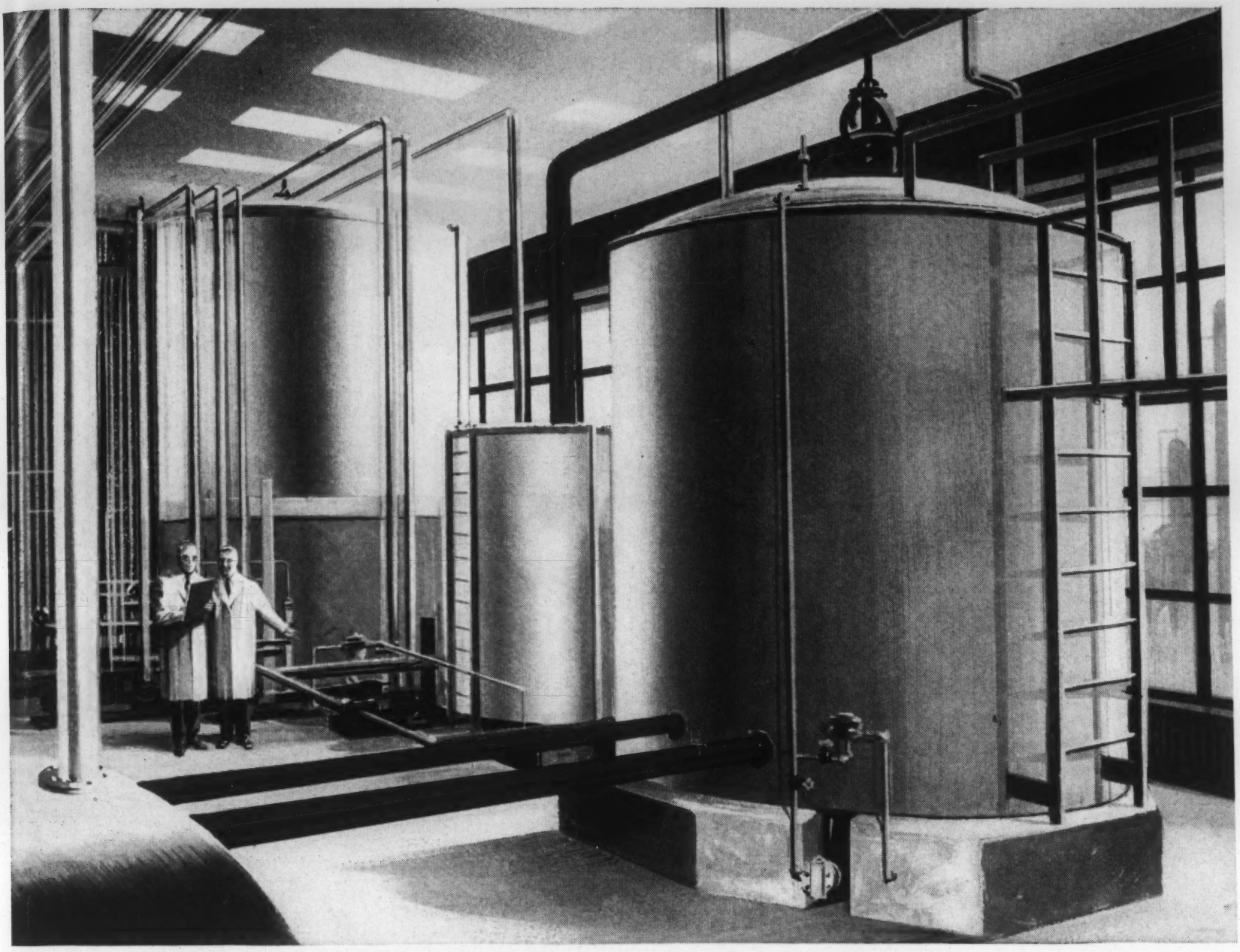

With added flexibility of THIOKOL Liquid Polymers –

New fiber-glass pipes have lasted twice as long as cement-lined steel tubing...three times as long as plastic-coated steel tubing

Fibercast Corporation has developed light-weight fiber-glass pipes which are demonstrating remarkable durability and resistance to corrosive chemicals. A THIOKOL liquid polymer/epoxy resin binder is used to reinforce the fiber-glass and provide the necessary flexibility.

In one chemical installation, light-weight fiber-glass pipes have already given twice the service life of cement-lined steel tubing, and three times the life of plastic-coated steel tubing. In another installation where iron pipes carrying sulphuric acid had to be replaced every 48 hours, fiber-glass pipes are still in operation after eight and one-half months.

One of the problems in developing this unique kind of piping was to produce a resin body which would have the compatible extensibility of glass fiber, at temperatures above 130°F., and also at lower temperatures. This problem was solved by adding THIOKOL liquid polymer LP-3 to the epoxy resin. The resultant material proved to be exceptionally stable, strong, and chemically resistant – ideally suited to withstand the rigors of field operation.

Thiokol's part in developing revolutionary fiber-glass piping is only one example of how THIOKOL liquid polymers are helping to create new and improved materials for use in a wide variety of industries. Perhaps, these versatile liquid polymers can help solve a problem for *you*.

Thiokol®

CHEMICAL CORPORATION

®Registered Trademark of the Thiokol Chemical Corp. for its liquid polymers, rocket propellants, plasticizers and other chemical products.

FOR MORE INFORMATION:
Mail coupon to Dept. 42, Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton, N. J. In Canada: Naugatuck Chemicals Division, Dominion Rubber Co., Elmira, Ontario.

Gentlemen: Please send me further details about THIOKOL liquid polymers.

Firm_____

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Your Name_____

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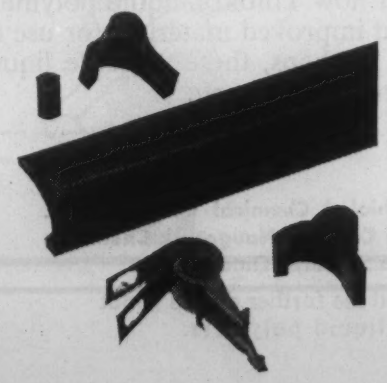
Readin', 'Ritin', and Reliability



Synthane plastic laminated bushings and breaker arms for automotive ignition.

Dependable operation of a school bus, a truck, or your own car involves the functioning of many parts. One breakdown can wipe out the memory of ten thousand trouble-free miles.

Some of these parts are made of laminated plastics. They're usually unseen, unsung, small in size yet efficiently performing their job.

Their cost is relatively insignificant when compared with the cost of equipment in which they work, but it should be sufficient to insure dependability.

Actually, what you pay for Synthane laminated plastics is little or no more than you'd pay for any other plastic laminate. But the Synthane price includes top quality materials, product control, excellent facilities and workmanship, an assurance of continuous supply, and a long reputation for fair dealing.

If you are interested in a reliable source of laminated plastics—sheets, rods, tubes, or completely fabricated parts, write for an interesting catalog or call our representative nearest you.

SYNTHANE

SYNTHANE CORPORATION, 3 RIVER RD., OAKS, PA.

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van huffel

ROLLER DIE COLD FORMED

metal shapes

can help you
simplify design
increase production
reduce costs

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HEAVY

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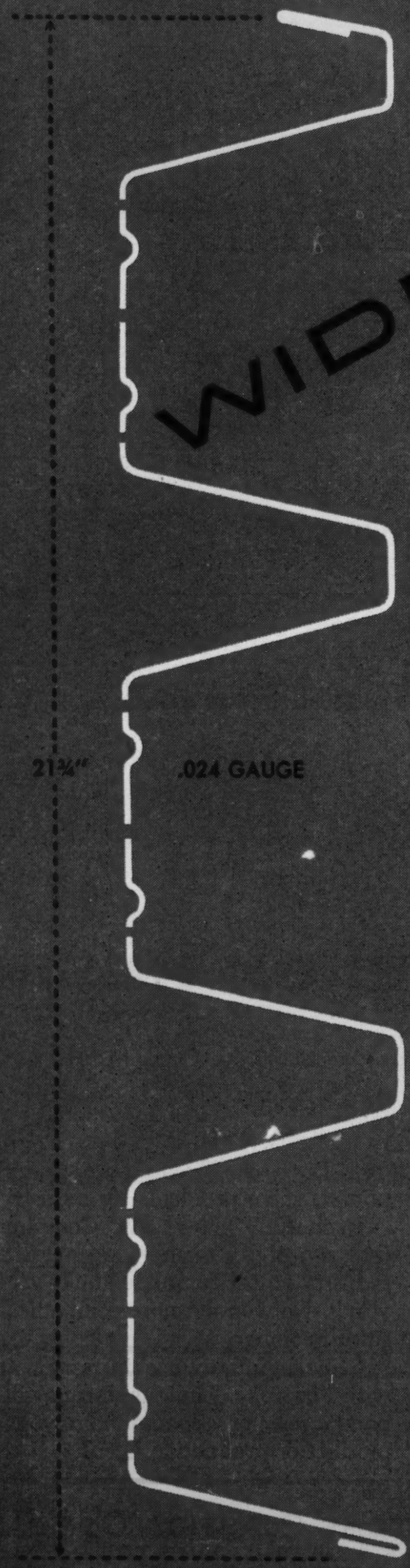
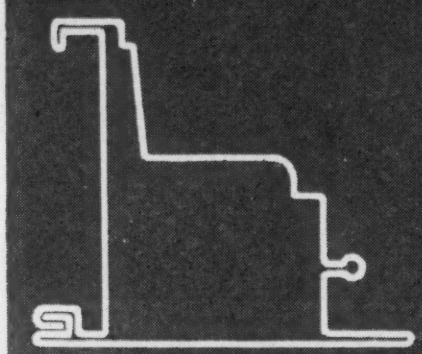
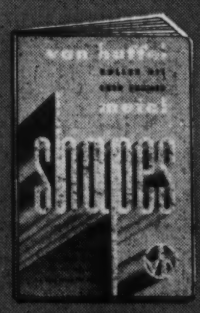




.312 GAUGE

Profiles illustrated will give you an idea of the wide range and versatility of Van Huffel Shapes roller die, cold formed to any lengths from a wide variety of metals: hot or cold rolled steel, high strength steels, stainless steel, coated steels, copper, brass, aluminum; from coiled strip ½" to 33" wide; in gauges from .003 to .312 from forming dies designed and built in our own plant.



THIS FREE 48 PAGE HANDBOOK

explains the basic engineering principles of Van Huffel Roller Die, Cold Formed Shapes and shows dozens of ideas that have taken shape in metal. Write for your copy today.

VAN HUFFEL TUBE CORP. · WARREN · OHIO

where ideas take shape in metal

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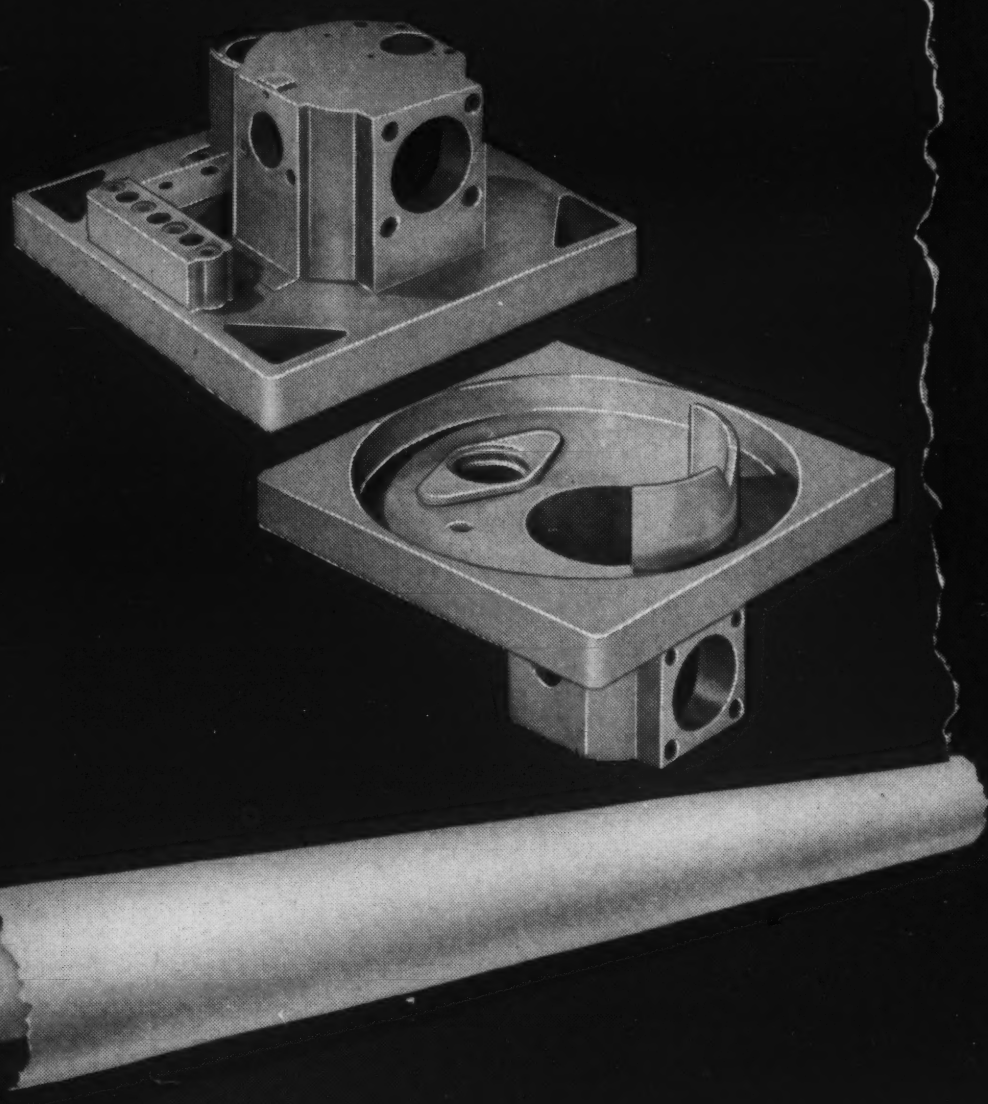
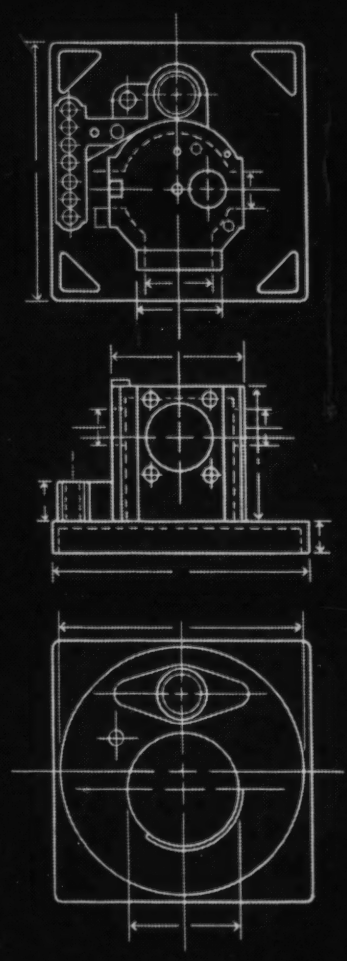
NOW, WITH AN EXON PVC COMPOUND, A SINGLE MOLD MAKES THIS COMPLEX CHLORINE TRAY.





PHOTOGRAPH COURTESY LUZERNE RUBBER COMPANY

Industry discovers how to

MAKE IT BETTER FASTER FOR LESS WITH EXON RESINS

This intricate chlorine tray weighs over fourteen pounds. Its complex design calls for twenty-four threaded metal inserts. Despite its weight and highly complicated design, Luzerne Rubber Company molds this tray as a single unit. Firestone Exon 4023 Type 1 PVC Compound makes this possible.

Despite a rigorous manufacturing cycle of time, temperature and pressure, Exon 4023 Compound's unique combination of properties gives this tray a shock resistance far superior to any possible with materials formerly used. Naturally, Exon maintains the same rigid standards of chemical resistance.

Here is an improved product now made at an increased production rate at lower costs. This is another example of how Firestone Exon Resins and Compounds solve problems for industry.

Exon 4023 Type I PVC Compound is just one of the many fine materials in industry's most complete line of versatile vinyls. No wonder more companies consult Firestone.

Check your own company's needs with Firestone. Their engineers will pinpoint a resin or a compound to your own product or production needs.

Firestone EXON RESINS

For complete information and technical service, call or write:

CHEMICAL SALES DIVISION: FIRESTONE PLASTICS COMPANY
DEPT. 848H, POTTSTOWN, PA. • A DIVISION OF THE FIRESTONE TIRE & RUBBER CO.
IN CANADA, CONTACT CHEMICAL SALES DIVISION, FIRESTONE TIRE AND RUBBER COMPANY OF CANADA LTD., HAMILTON, ONT.

INDUSTRY'S MOST COMPLETE LINE OF VINYLS ENGINEERED TO YOUR SPECIFIC NEEDS

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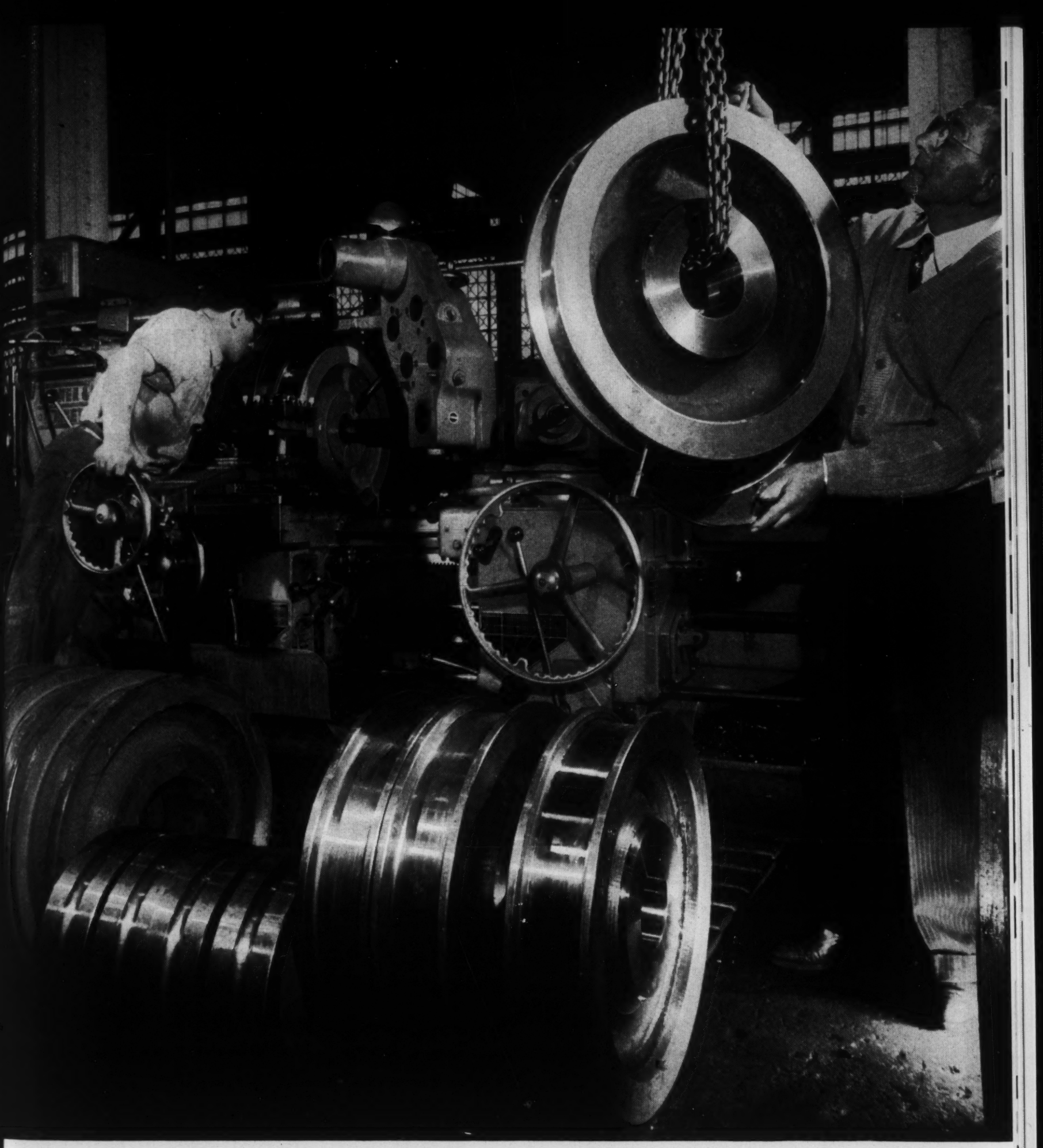
For more information, circle No. 499 ➤



Good, Sturdy Blanks all the way through

Fine lot of crane wheels, aren't they? Beautifully machined. They look solid and strong and dependable all the way through. And they're just as sturdy as they look, for they're made from Bethlehem forged-and-rolled blanks.

Bethlehem's unique forging and rolling process imparts soundness, high strength, and excellent grain flow. It makes the machinist's job easier, less costly; the forgings have no hidden flaws to snag and slow the cutting tool.

For making circular steel parts, our forging and rolling process simply can't be surpassed. Bethlehem blanks are widely used in the making of heavy-duty gears, crane and sheave wheels, turbine rotors, flywheels, pipe flanges, and many other circular products. Available in either carbon or alloy steel, they can be furnished in a wide choice of sections and in sizes from 10 to 46 in. OD.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For whatever you make...

N-A-X® HIGH-TENSILE STEEL BUILDS IN STRENGTH WITH LONGER LIFE

Today's emphasis on fast mechanized freight car loading and unloading brings the superior qualities of N-A-X HIGH-TENSILE steel into sharp focus.

For boxcar flooring, increased mechanization means bigger, heavier and faster moving lift trucks, added abuse from still more weight concentration. For gondola flooring, increased mechanization means still more load impact and abrasion to go with the deteriorating effects of constant exposure to weather.

N-A-X HIGH-TENSILE steel solves these troublesome problems like none other. Used in Stran-Steel Corporation's famous N-S-F®, nailable steel flooring, N-A-X HIGH-TENSILE builds in extra strength, adds longer life. And top resistance to impact and atmospheric corrosion, plus ready weldability, makes N-A-X HIGH-TENSILE exceptionally suited to the special needs of railroad equipment manufacturers and railroads alike. No wonder sixty-three of the nation's leading railroads have ordered N-S-F for their freight cars.

CHECK THESE IMPORTANT ADVANTAGES FOR YOUR JOB:

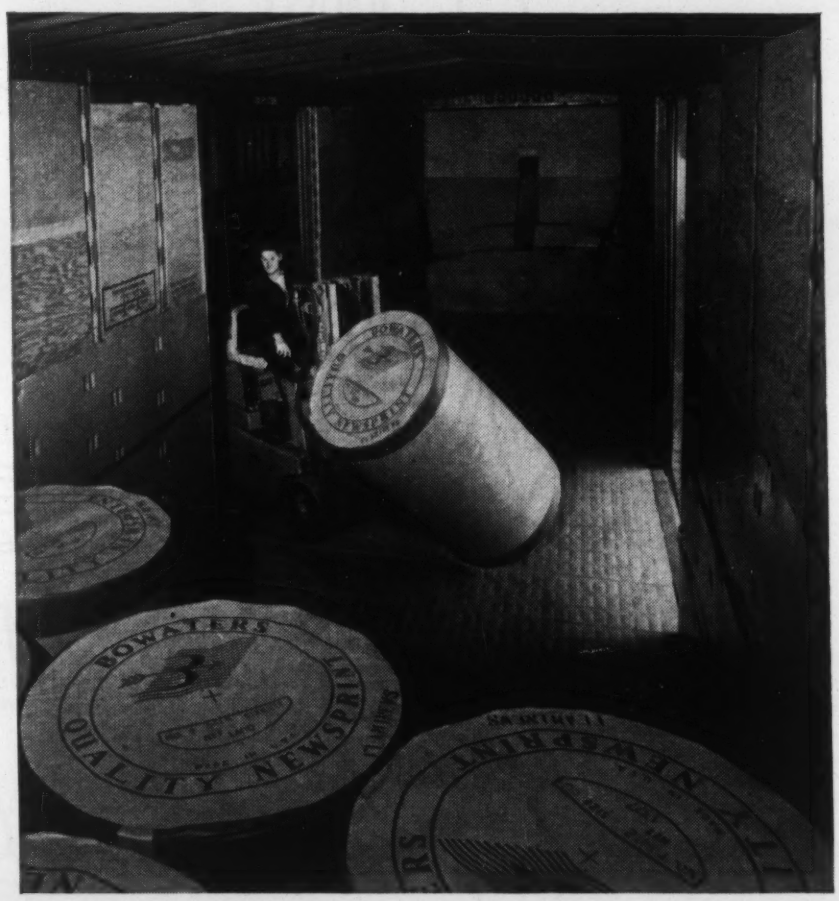
N-A-X HIGH-STRENGTH steels—both N-A-X HIGH-TENSILE and N-A-X FINEGRAIN—compared with carbon steel, are 50% stronger • have high fatigue life with great toughness • are cold formed readily into difficult stampings • are stable against aging • have greater resistance to abrasion • are readily welded by any process • offer greater paint adhesion • polish to a high luster at minimum cost.

Although N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon steel, N-A-X HIGH-TENSILE is recommended where resistance to extreme atmospheric corrosion is important.

For whatever you make, from steel shop boxes to steel freight cars, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight and economy into your products. Let us show you how.

Here again N-A-X HIGH-TENSILE *steel proves its ready weldability. To manufacture Stran-Steel Corporation* N-S-F®, *nailable steel flooring, no less than* eight *separate welds between each two channels are required.*

Tough N-S-F®, *nailable steel flooring of* N-A-X HIGH-TENSILE, *has already won wide acceptance with leading railroads everywhere. So much so, in fact, that more than 50% of all new boxcars now being built are ordered with it.*



This typical modern fork-truck with its giant newsprint roll weighs a whopping 5,500 pounds! N-A-X HIGH-TENSILE *takes even this kind of concentrated abuse easily, lasts for the life of the car.*

N-A-X
HIGH-STRENGTH STEELS

N-A-X Alloy Sales Division, Dept. D-5

GREAT LAKES STEEL CORPORATION

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NATIONAL STEEL CORPORATION

N-A-X Alloy Sales Division, Dept. D-5
Great Lakes Steel Corporation, Detroit 29, Michigan

☐ Please send me 12-page illustrated technical catalog on N-A-X HIGH-STRENGTH steels.

☐ Please have your representative contact me.

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Company_____

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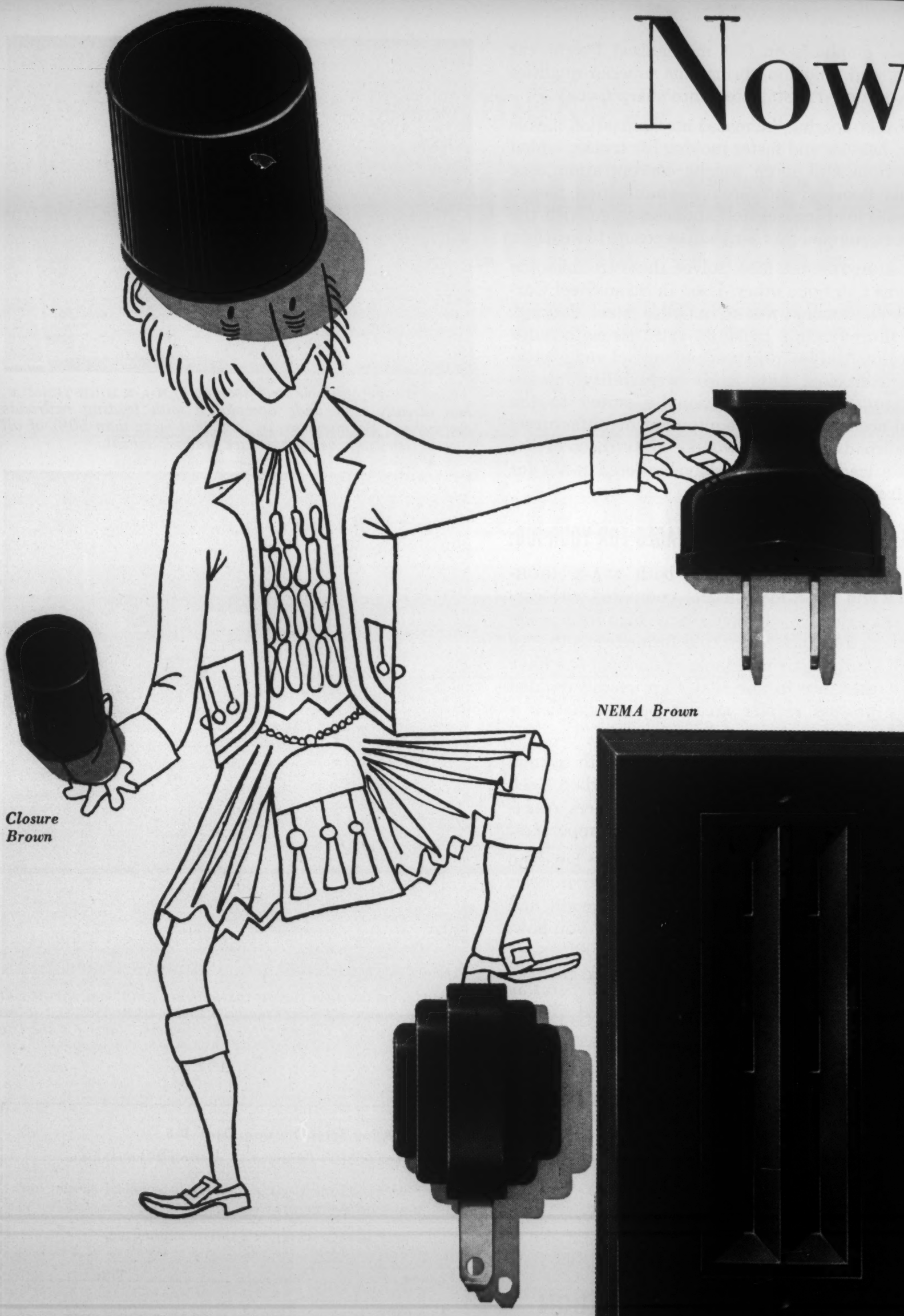
Now!



Closure Brown

NEMA Brown

Plaskon® wood-filled urea

A LOW-COST, GENERAL-PURPOSE MOLDING COMPOUND

Wood-filled urea—a well-established favorite with European molders—is now being produced in the United States by Barrett in all-new facilities, engineered and built to assure a dependable supply of this high-quality thermosetting PLASKON Molding Compound.

Available in black and in NEMA and closure brown, wood-filled PLASKON Urea offers many molding and end-product benefits found in *no* other molding compound.

OFFERING MOLDERS:

1. A low-priced quality thermosetting molding compound suitable for a multitude of general-purpose applications.
2. Excellent for high-speed automatic operations . . . available in two plasticity types.
3. Uniform granulation and bulk for pilling and bulk loading.
4. Cure rates comparable to cellulose-filled urea.

OFFERING END-USERS:

1. Color fastness
2. Superior electrical properties
3. Resistance to common household chemicals
4. Hard, non-electrostatic surfaces

Wood-filled PLASKON Urea can very likely open the door to more profits, new markets for *you!*

For complete technical data — and molded samples — write *today* to:

BARRETT DIVISION, Allied Chemical Corporation, 40 Rector Street, New York 6, New York

Barrett PLASKON

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Eastern's research, development and production facilities, devoted exclusively to stainless steel in sheets and plates, are available to you through the finest

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in the whole bright new world of stainless steel.

Your local steel service center offers prompt service, an opportunity to reduce your inventory, and quick delivery of in-stock materials.

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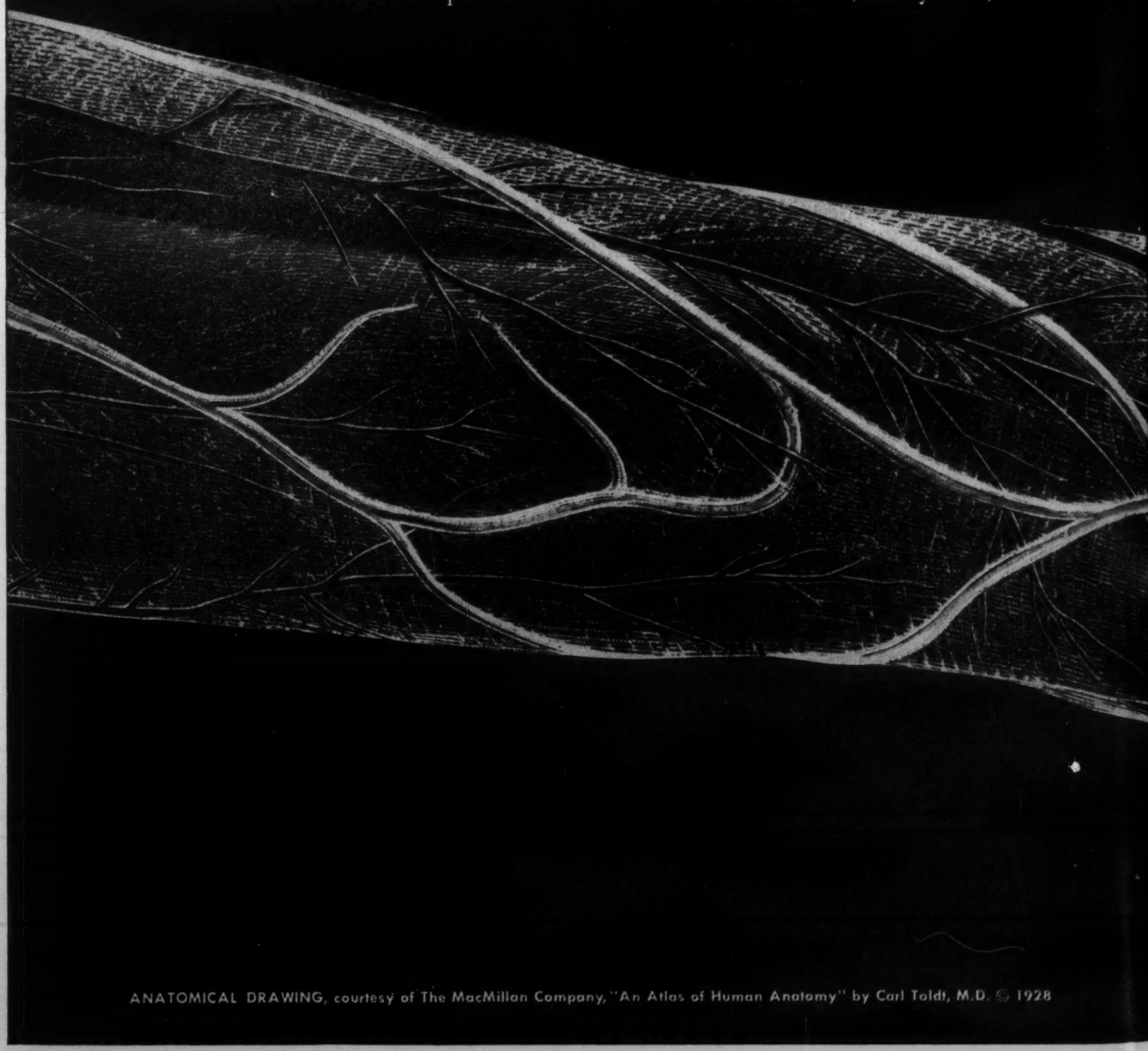
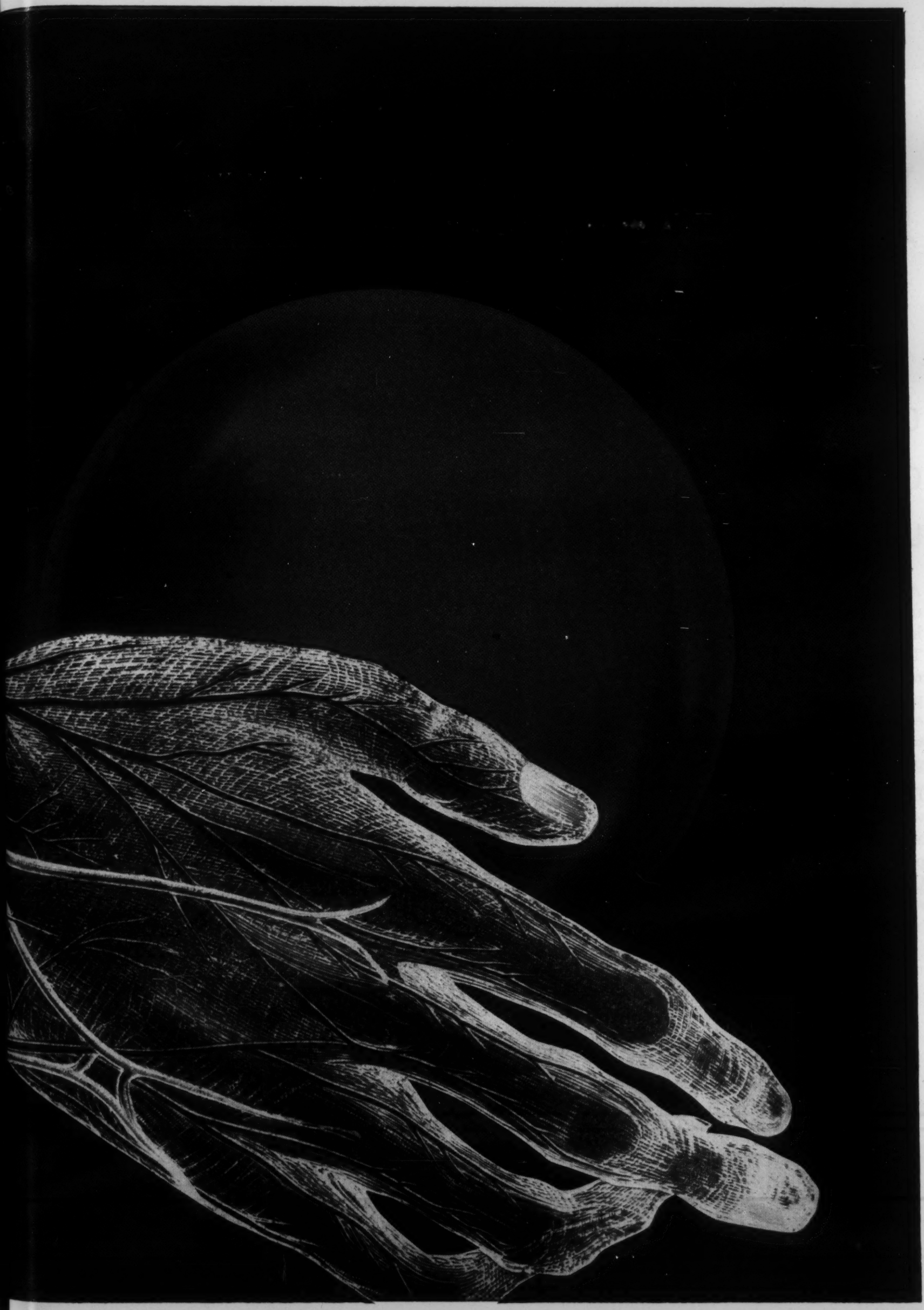


ANATOMICAL DRAWING, courtesy of The MacMillan Company, "An Atlas of Human Anatomy" by Carl Toldt, M.D. © 1928



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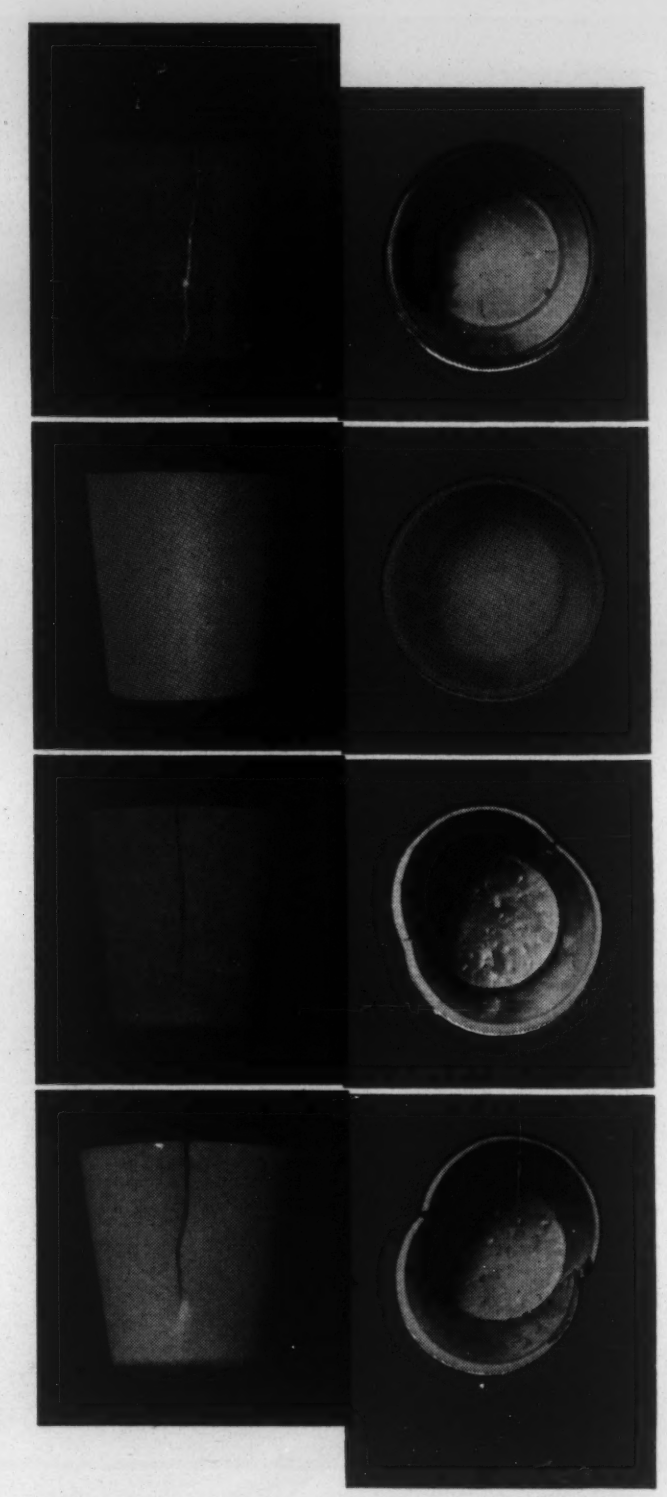
UNRETOUCHED PHOTOS

DRAMATIC PROOF ▶

of **DAPON**® resin's outstanding stability under heat and humidity

As graphically shown here, Dapon Resin does not distort, degrade or discolor under long exposure to high heat and humidity. This outstanding dimensional stability, coupled with Dapon Resin's high electrical properties and chemical stability even under extreme conditions, may provide the answer to your high-temperature high-humidity plastics stability problems.

Dapon Resin is easily compounded with a wide variety of mineral and fibrous fillers and has extremely low molding and post-mold shrinkage. And in addition, Dapon Resin can be molded in a range of solid and pastel colors.



MELAMINE "A"
after 10 days under test

DAPON
after 90 days under test

POLYESTER "A"
after 18 days under test

POLYESTER "B"
after 22 days under test

TEST DATA: An equal number of test cups were molded under normal conditions from commercial polyester, melamine and DAPON Resin. The cups were half filled with tap water and placed in a laboratory oven at a constant 212°F temperature, the water being replaced daily. The cups were examined at regular intervals and removed from the oven when they had reached the condition shown in the unretouched illustration.

At your request, we will be glad to send you complete technical data on Dapon Resin so that you can investigate this unusual plastic as the answer to your specific problems.

Properties of **DAPON*** Resin

Stable, free-flowing white powder • Easy to store, easy to mold, easy to color • Molded products have excellent surface finish • Good physical strength • Low moisture absorption • Chemically resistant • High-temperature and high-humidity resistance • Outstanding dimensional and chemical stability • Fine electrical properties even at high-temperature and high-humidity.

**DAPON Resin is the registered trade name of Food Machinery and Chemical Corporation's brand of diallyl phthalate prepolymer.*

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

FMC Organic Chemicals Division

161 EAST 42nd STREET, NEW YORK 17, N. Y.

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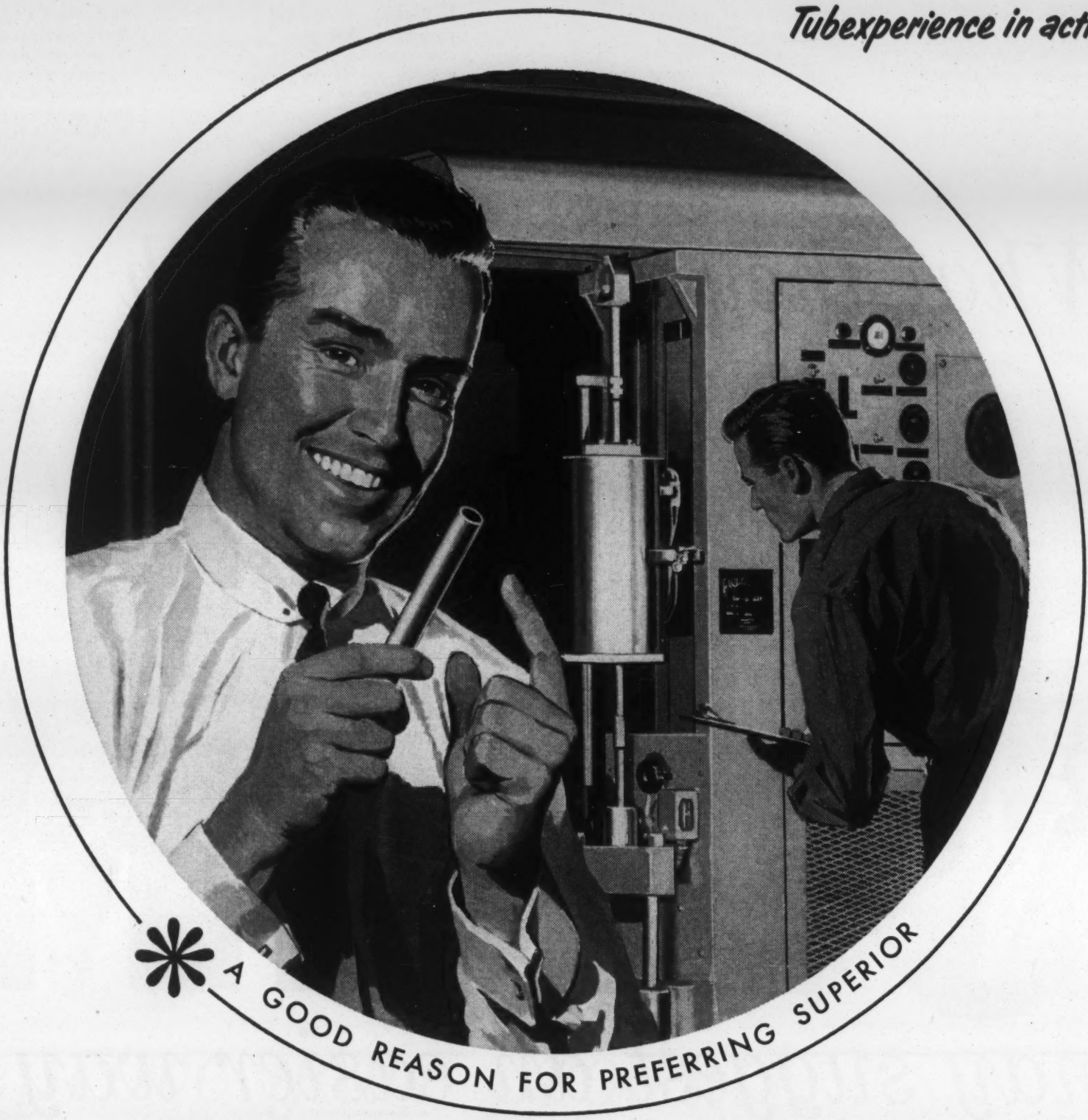

"They use this Super Alloy tubing in missiles, rockets and jets

—so you know it can lick your heat and corrosion problems!"

*"It's made by Superior Tube in your choice of 15 different materials. Believe me, this tubing can take the severest conditions of heat, corrosion and oxidation. Has very high fatigue and creep strength even at temperatures over 1000°F."

If you have a temperature and corrosion problem that causes failure no matter what type of tubing you have tried, get your Superior distributor to order Super Alloy tubing for you—it is the tubing for virtually every critical application of this nature.

Super Alloy tubing offers the important properties mentioned above, plus the dependability and longer service life built into it by Superior skills and experience. We will put your tubing through many special examinations if you want us to—eddy current and ultrasonic, hydrostatic, and hot tensile tests, stress rupture tests, qualitative and quantitative analysis, and many others—for your complete assurance in its ability to perform as required.

Our continuing test program on Super Alloy tubing has amassed much useful information on mechanical properties. You will want to make a study of them and their potential for use in your applications. They are covered in our Bulletin 70. Send for copies. Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

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All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company • 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

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To prevent moisture and dust from entering automobile light sockets, a **chem-o-sol** was specially formulated for an economical high-speed dipping process (no costly molds required). It provides a tough, flexible coating. *(Watts Electric & Mfg. Co.)*

To resist corrosion, drums, tanks, and other large irregularly-shaped objects are sprayed with a structurally strong **chem-o-sol.** Cost savings of up to 35% result, and films of from 5 to 100 mils are possible.

To provide an essential coating for glass yarn used in strong, weather-resistant screening, a **chem-o-sol** with the correct flow properties was produced for economical application by high-speed die-wiping. *(Owens-Corning Fiberglas Corp.)*

To produce a tight seal that is permanently flexible and durable, a specially formulated **chem-o-sol** was tailored for clay pipe joints. A "flowed-in" gasket, it's applied by an in-plant molding process.

What they're doing with

may suggest an easier way to i

ECONOMICAL TO APPLY
chem-o-sol ALSO HELPS CUT PRODUCTION COSTS

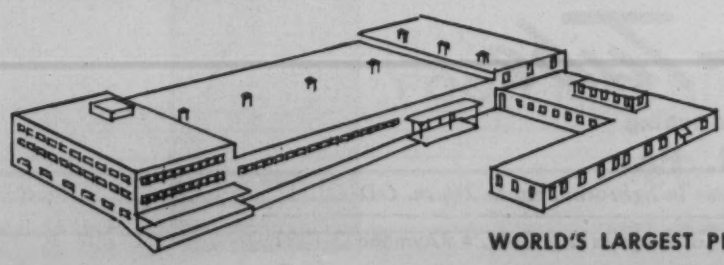
These are just a few of the applications already developed for Chem-o-sol. So versatile is this polyvinyl dispersion . . . so advanced the research, so vast the formulating experience and production capacity of Chemical Products Corporation that Chem-o-sol's product improvement possibilities are virtually *unlimited.*

For Chem-o-sol is more than a coating or molding *compound.* It is a new production tool! Formulated as a liquid without volatile components, it is converted to a strong, resilient solid simply by heating to about 350°F., *without pressure.*

Since each Chem-o-sol formulation is "tailor-made" to best suit the specific requirements of the end use, the formulator's touch is indispensable for translating ideas into reality.

To its practical experience, unsurpassed in point of time or scope, Chemical Products Corporation adds the world's largest and most modern facilities for the development and production of polyvinyl dispersions, including a completely equipped research laboratory to serve you.

IS THERE AN IDEA HERE for improving your own product? Then tell us about the proposed end use of Chem-o-sol.



WORLD'S LARGEST PLANT OF ITS KIND

Chemical Products
CORPORATION
East Providence, R. I.

Member Vinyl Dispersion Division of the S.P.I.

To impart a slip-proof, safety grip and increase wearability of cotton work gloves, palms and fingers are strategically dotted with **chem-o-sol** specially formulated to permit printing on fabrics at high speeds. *(Wells Lamont Corp.)*

To deaden noise, protect dishes from chipping, and resist grease and detergents, the familiar drainer is dipped in a special **chem-o-sol.** Wire constructions and metal and glass objects are coated easily and economically because only one dipping operation is necessary. Thickness to 60 mils is possible, in wide range of finishes.

To seal the new dry type automotive air cleaner into the car silencer and act as a structural member of the pleated paper element, a **chem-o-sol** was compounded for high-speed molding. Pre-cut gaskets and metal stampings were eliminated. *(Fram Corporation.)*

To improve heat resistance and physical and electrical properties of coatings for flexible sleeving (spaghetti tubing) used in electrical components, a **chem-o-sol** was tailor-made for heat resistance of more than 2000 hours at 225°F.

·o·SOL

improve your product

TECHNICAL FACTS ABOUT chem-o-sols

Chem-o-sols possess all the outstanding physical and chemical properties associated with polyvinyl chloride resins. Listed below are some of the properties available in almost any combination.

COLOR CHOICE — unlimited

TENSILE STRENGTH — as required from 1000 psi. to 2700 psi.

PERCENT ELONGATION — 350 to 600

HARDNESS (shore A2) — as required from 10 to 100
(shore D) — up to 65

FLEXIBILITY — to temperatures as low as **—65°F**

CHEMICAL RESISTANCE — outstanding to most acids, alkalies, detergents, oils and solvents

HEAT RESISTANCE — available to 225°F for as long as 2000 hours and to 450°F for over two hours

DIELECTRIC STRENGTH — minimum of 400 volts per mil when fused in sections 3 mils thick and over

SOLIDS CONTENT — 100%. Chem-o-sols can be molded in very thick sections

VISCOSITY — as required for dipping, die wiping, molding, casting, spraying, or spreader coating

CHEMICAL PRODUCTS CORPORATION
Dept. M-6, King Philip Road
East Providence 14, R. I.

Please send me a free copy of your **chem-o-sol** Brochure.

Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....

Proposed end use .....

.....

Application method .....

.....

Going Plastisols One Better... **chem·o·sol®**

For more information, turn to Reader Service card, circle No. 492

Impact resistance—The image of impact can take many forms. To a train-conscious youngster, impact might be the crash-coupling of freight cars. To the contour miner, impact is a mammoth dipper smashing into frozen highwall. To the ordnance man, impact is a shell striking armor plate. Whatever the image, impact implies one thing—toughness.

Toughness is the ability to absorb energy—to "give" under a shock load without fracturing. This property—toughness—in steel, more than in any other material, has been vital to the building of the modern world. Steel's ubiquitous role, however, belies the complexity of toughness. Because just as there are many kinds of steel, so there are many degrees of toughness, and a given steel's toughness is shaped by the admixture of its composition, manufacture and fabrication.

The design engineer, if he is to do his job well, must know his toughness in order to select the right steel for the job. He must know something of how toughness is achieved, because this often can result in using less expensive steels. The geometry of a part or structure is also important to its toughness, and here the designer reigns supreme.

In steelmaking, toughness and strength are determined by composition and manufacturing steps. Often, as is the case with USS* "T-1" Constructional Alloy Steel, a very high level of strength and toughness is obtained through selection of alloying elements and by proper heat treatment. The steelmaker can help you obtain the best combination of strength and toughness along with other desirable properties like weldability, corrosion resistance, formability and wear resistance. He can also recommend post-fabrication heat-treating practice where it is required to develop mechanical properties or relieve stress in fabricated assemblies.

Clearly, toughness is complex. But for any application, there is one best steel no matter what combination of properties you need. You are almost certain to find that steel among the great family of USS Design Steels: Carbon, High Strength, Alloy and Stainless. Our experience is yours for the asking. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. You'll find our nearest representative in the Yellow Pages listed under United States Steel.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

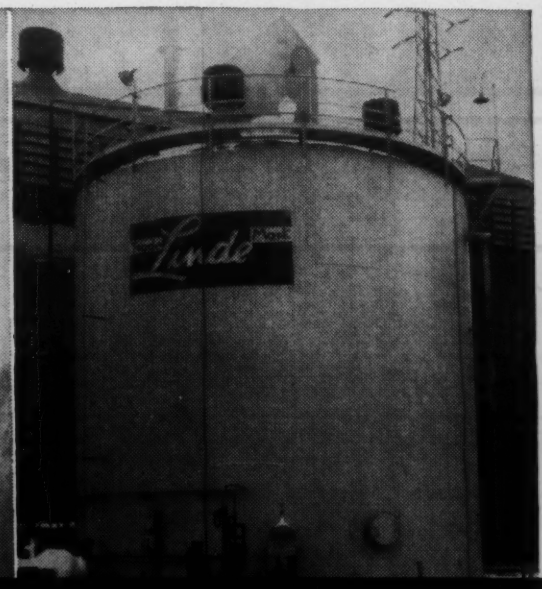
*TRADEMARK

STEELS FOR DESIGN

Lower Left—Problem: Design dump cars for tunnel excavations to remove rock. Must have high impact resistance, plus corrosion resistance to withstand alternate wetting and drying. Solution: Build cars from USS COR-TEN* High Strength Steel. Pay-off: Cars take minimum maintenance, have been in continual service for six years, and are still in excellent condition.

Lower Middle—Problem: Design a 60 cu. yd. shovel that could take the terrific abuse of all-weather overburden removal. Solution: Bucket, bail, dipper stick and crowd rack built entirely of welded USS "T-1"* Steel, a constructional alloy steel having exceptional toughness at below zero temperature and which can be field-welded and flame-cut. Pay-off: Outstanding performance in 7-day-a-week, 24-hour-a-day service with minimum maintenance.

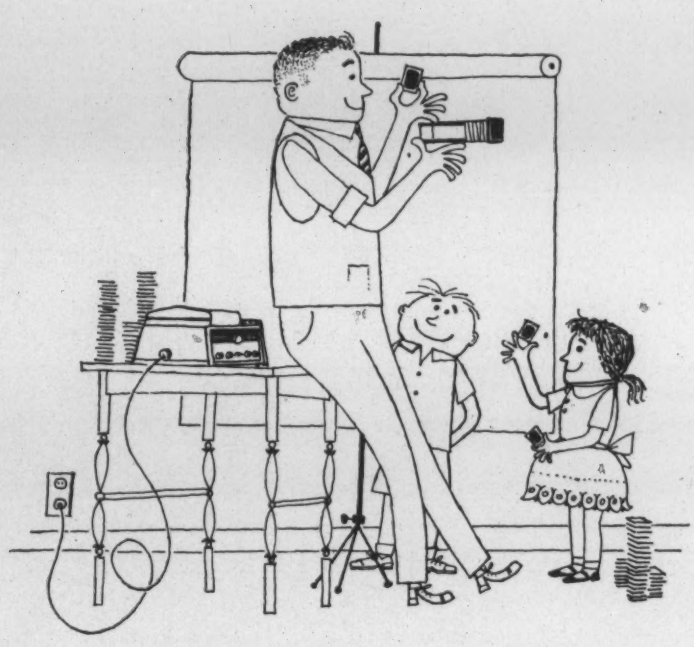
Lower Right— Problem: Design a tank to hold the liquid equivalent of 10 million cubic feet of oxygen at 300°F. below zero. Solution: Tank was designed with impact-resistant austenitic USS Stainless Steel. Pay-off: Tank can withstand sudden changes of pressure, temperature changes and volume at low temperatures that would shatter other materials.



From the Dow family of plastics...look to

Styron 440M

for easy flow, high heat and impact resistance



Beauty . . . strength . . . durability. Styron* imparts plenty of each to this smartly designed slide projector.

For the top cover, Styron 440M was selected for its high impact strength, high gloss finish and resistance to heat from the projector's 500-watt bulb. Styron 440M was also used for the slide holder which must stand up under the impact and friction imposed by repeated handling and mechanical action. The excellent moldability of this versatile Dow thermoplastic makes possible thick side walls and extremely thin separator sections for the slide holder.

The crystal clarity of Styron 666 was put to good use in a transparent cover for the escutcheon. Its excellent flow characteristics reduce the weld lines that appear around apertures in the panel and facilitate second-surface finishing.

Twelve different formulations of Styron in an almost unlimited choice of colors contribute to good design and keep production problems scarce in many applications. For more information, contact your Dow man now. THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 1535D. *Trademark of The Dow Chemical Company

From projectors to pipe lining—

Dow plastics lead the way

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STYRON* • TYRIL* • ETHOCEL* • SARAN • POLYETHYLENE • PVC RESINS

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For more information, circle No. 535

pace your industry in product quality and value.... follow the **trend** to...

Brass · Copper · Aluminum

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If you are planning a new product, let Scovill Technical Service help you select the proper alloy, temper, finish, etc., to bring out the BEST in it . . .

SCOVILL MANUFACTURING COMPANY
MILL PRODUCTS DIVISION
99 MILL ST., WATERBURY 20, CONN.
PHONE PLAZA 4-1171

MADE IN U.S.A.
TO THE STANDARDS
OF AMERICAN INDUSTRY
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*made better to bring out the **BEST** in your products*

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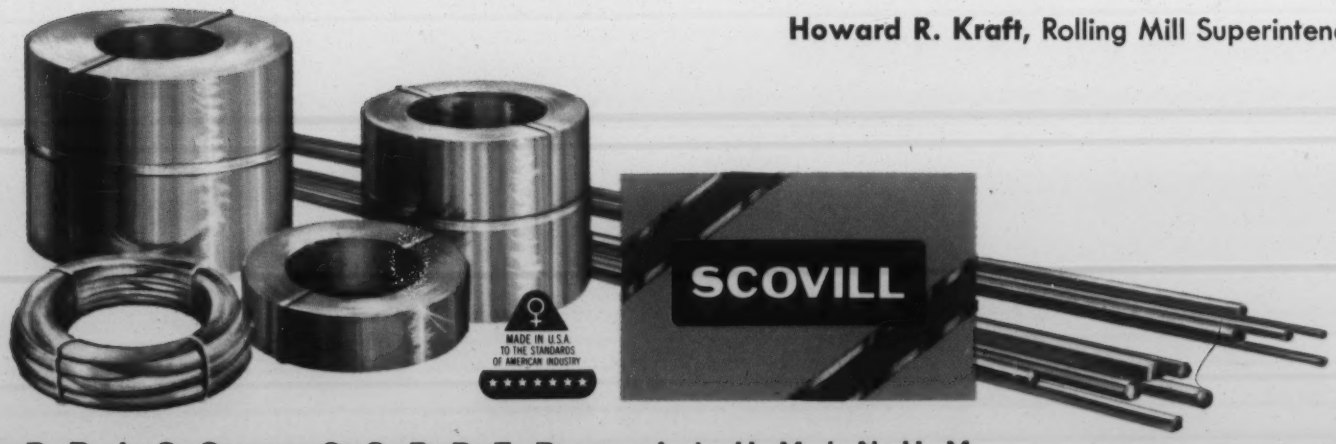
"Ninety-nine times out of a hundred, fabricators who pride themselves on smooth-running and profitable operations give a large share of the credit to the mill products they use.

"For example, every working day we roll miles of strip through this mill. Any significant variation of any kind in the metal would eventually show up as a variation in performance on the fabricator's production line.

"That's why at Scovill every experienced worker, every ultra-modern machine and method, is dedicated to maintaining an exceptional standard of uniformity in our Mill Products... to safeguard quality on your production line...to bring out the BEST in your products."

Howard R. Kraft, Rolling Mill Superintendent



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(8000 cps. at 25° C)

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(5.25 mols/kg.)

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NEW TOOL
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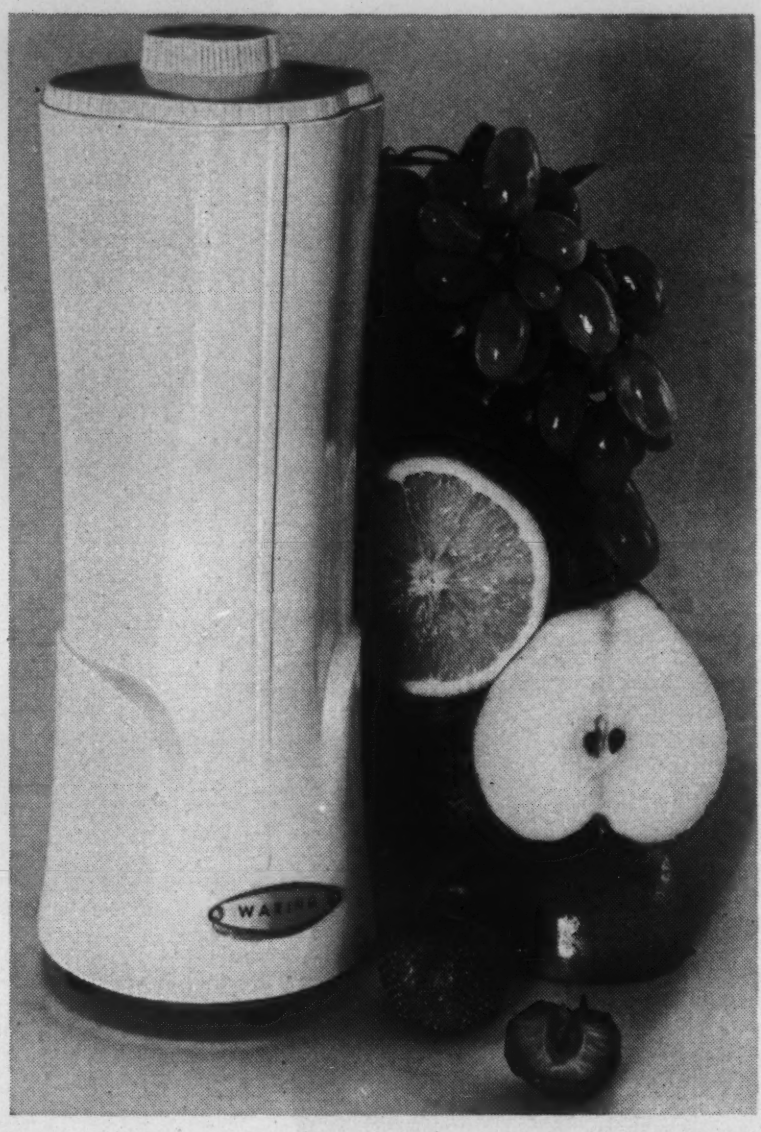
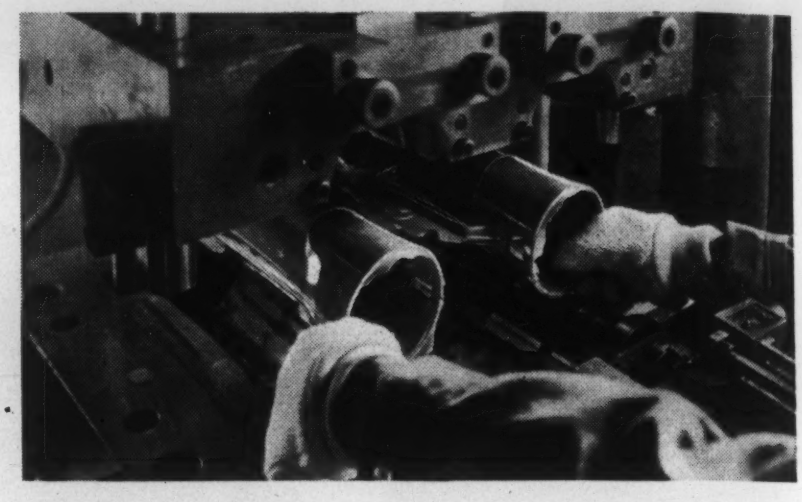
CYANAMID

PLASTICS IN ELECTRICAL DESIGN

Drink Mixer and Server...One Graceful Molding of CYMEL®



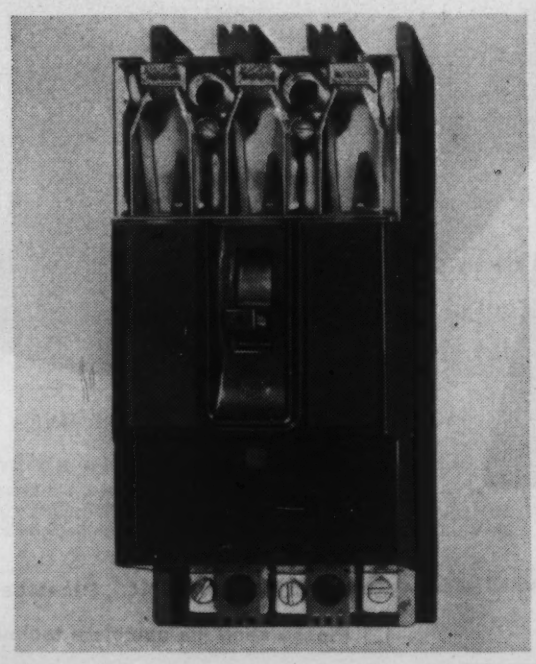
Conceived as both mixer and server of beverages and sauces, the new Waring Drink Mixer serves graciously anywhere in the home. In accord with the need for style, portability and economy, the mixing cavity, motor housing, handle and pouring spout are molded in one unit of CYMEL 1077 melamine molding compound—familiar to consumers in popular MELMAC® dinnerware. This styling in CYMEL keeps down size, weight, and cost. CYMEL provides insulation, strength, resistance to heat and staining, excellent stability, low moisture absorption, permanent rich molded-in color and hard surface.

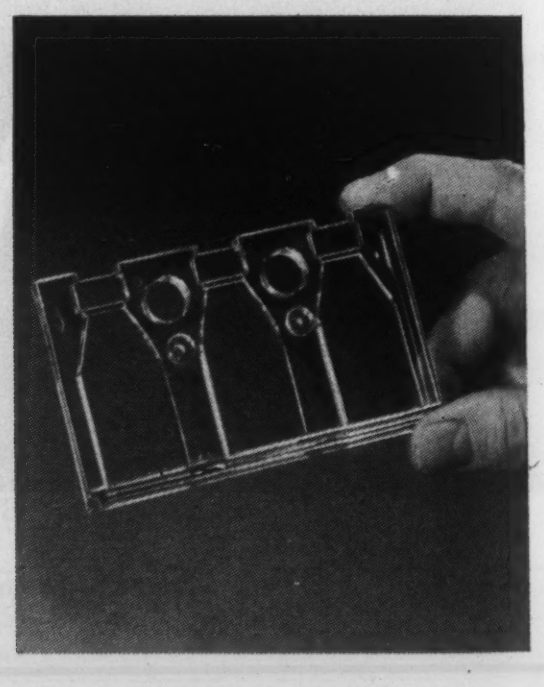


Two complete one-piece mixer bodies are molded of CYMEL in each cycle. Mixing cavities and motor housings are formed by cores. Here, mold is open, motor housing cores have been automatically retracted, and the two mixers are being manually removed from top-cavity cores. Molder is Shaw Insulator Company.

CYMAC® Window on Circuit Breaker Contacts

A removable transparent cover through which contacts are clearly visible is the outstanding feature of a new circuit breaker recently introduced by Standard Control Division of Westinghouse Electric Company. The cover of the Saf-T-Vue circuit breaker, which reveals at a glance whether contacts are open or closed, is molded of CYMAC 201 methylstyrene acrylonitrile copolymer, which provides necessary transparency, heat and break resistance, and surface hardness at comparatively low cost.





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AMERICAN CYANAMID COMPANY
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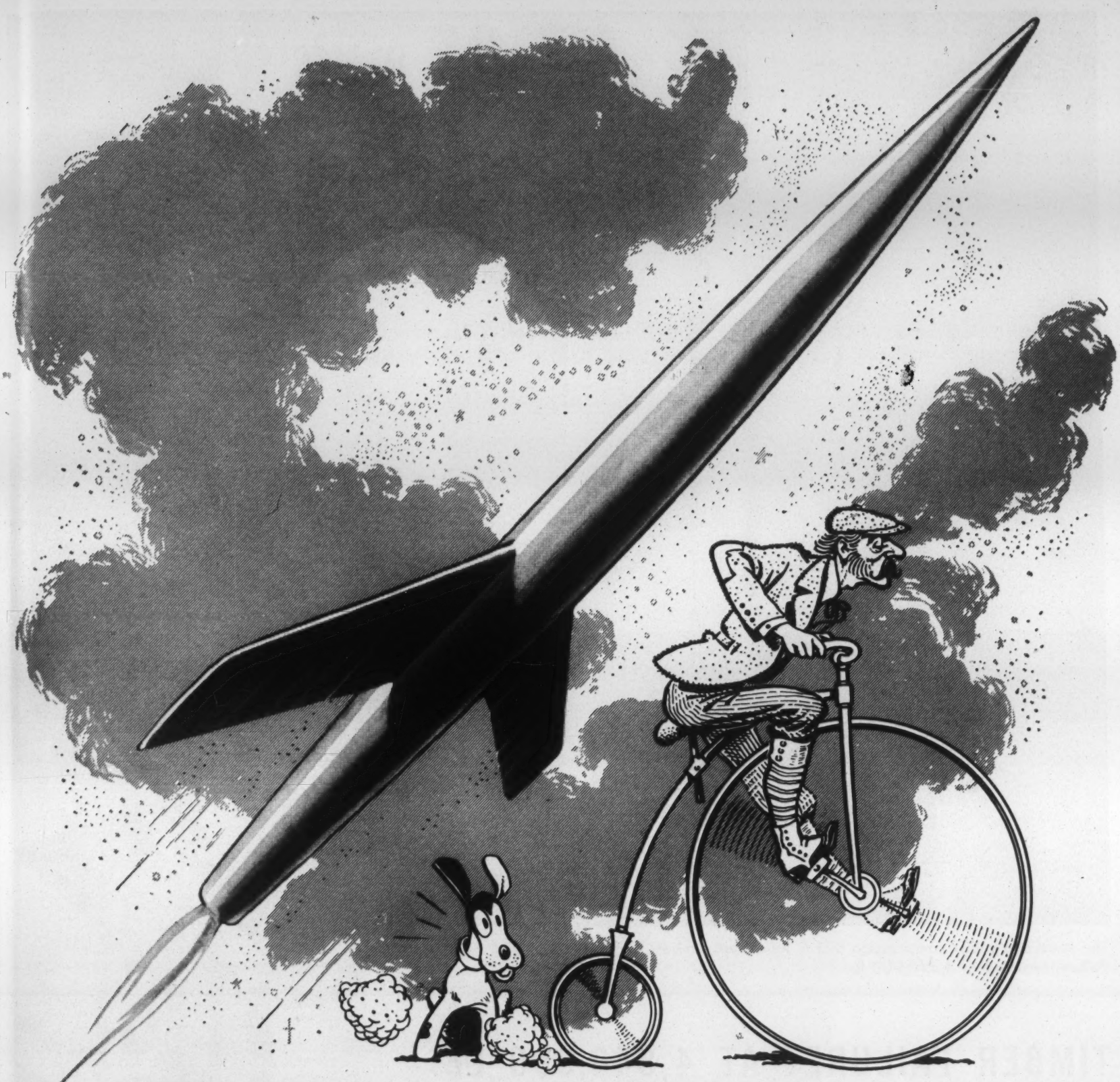

Seventy-five Years ◇◇◇

TEN MILES an hour was "speed" in 1883 when Wyman-Gordon started to make forgings for the high-wheel bicycle. Through the 75 intervening years forgings have made important contributions to the phenomenal advances in propulsion. Progress from the first "horseless carriages"...from the early "flying machines"...to the supersonic speeds of today ...would not have been possible without forgings produced by the most advanced techniques of the day.

Wyman-Gordon is proud of its achievements in these fields and, as the largest producer of automotive and aircraft forgings, is prepared to accept the challenge of the future. Today, as for 75 years, there is no substitute for Wyman-Gordon quality and experience.

WYMAN-GORDON COMPANY

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS
HARVEY, ILLINOIS • DETROIT, MICHIGAN

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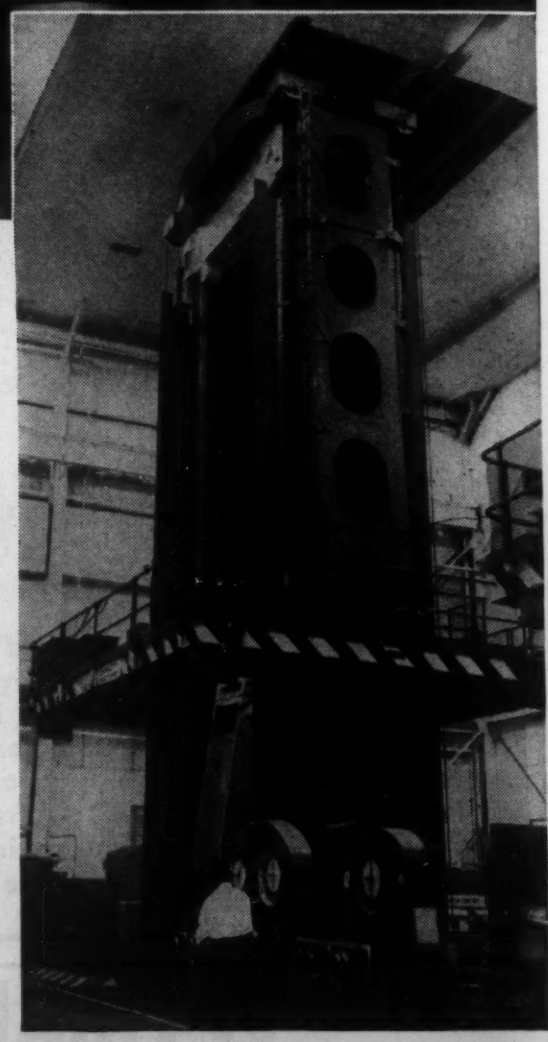
The specimen under compression test is laminated timber, 10 ft. in length and 30 in. square. Failure occurred at 4,840,000 lb.



TIMBER FAILURE: AT 4,840,000 LB.
in a giant B-L-H Universal Testing Machine

Characteristic of B-L-H ability to design and construct testing equipment to meet any requirements is this 5,000,000-lb. testing machine, one of the largest in the world. Specimens up to 40 ft. in length can be accommodated, either in tension or compression. With it, designers and engineers are no longer restricted to testing small scale models. They can determine the actual performance of columns, cables, trusses, girders and other structural components of bridges, buildings, etc.

For the best in testing, see B-L-H first. Name your problem—tension, compression, fatigue, creep, impact or torsion—and we can supply you with the finest equipment available to solve it. We also offer a broad variety of accessory equipment and instrumentation. Write today to Dept. 3-F for literature or ask to have a B-L-H man call on you and show what we have to offer.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

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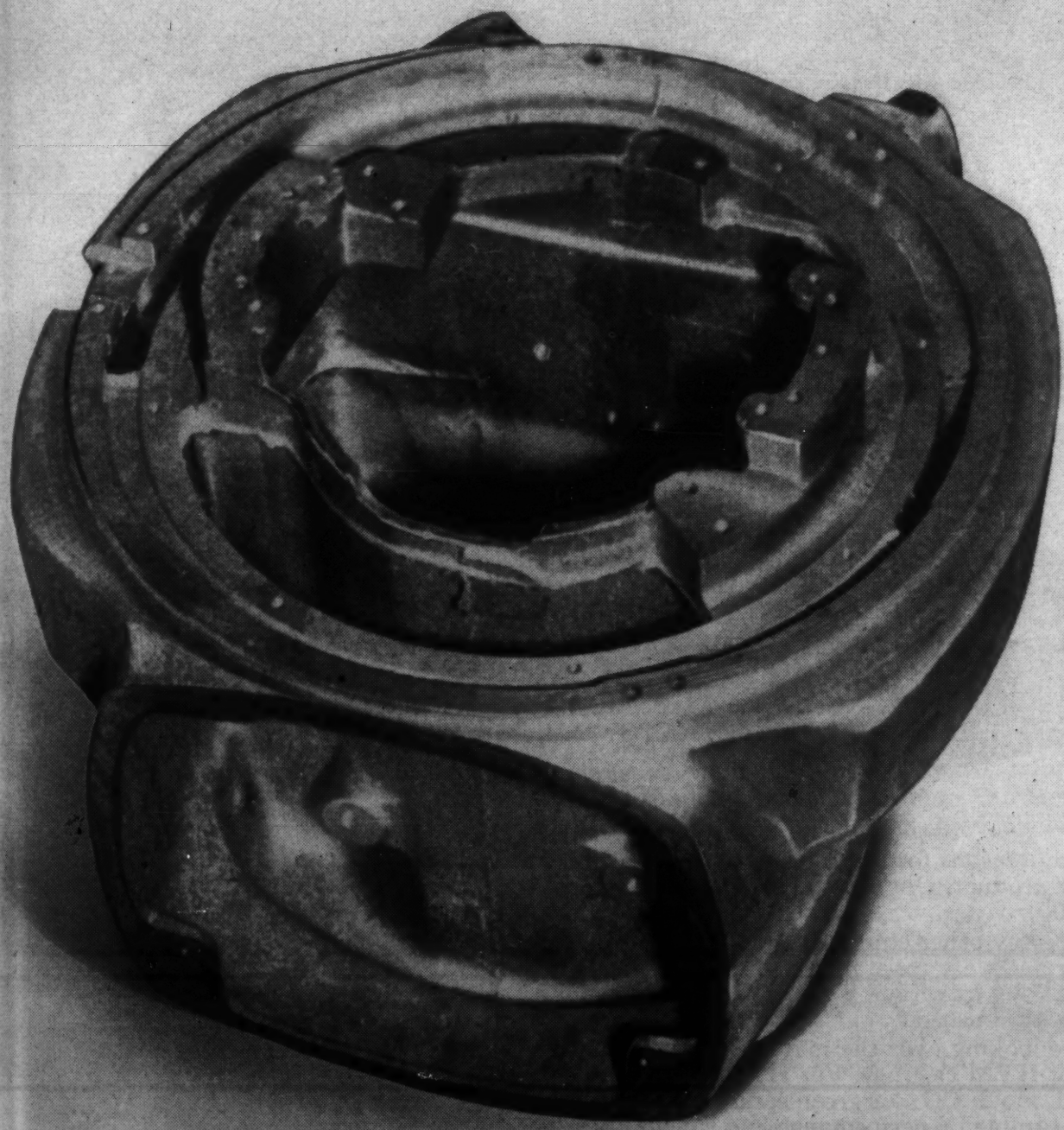
For more information, circle No. 399

Pay less for more strength! Tenzaloy the self-aging aluminum alloy needs no heat treatment! If your aluminum castings are too large or too intricate for heat treatment, if your heat treating facilities are limited, if you need superior strength than you get from ordinary heat-treated alloy demand "Federated Tenzaloy" developed by Federated to meet the need for a superior aluminum alloy that ages at room temperature. Tenzaloy eliminates rejects due to warpage, expansion, and internal stresses caused by quenching. Tenzaloy finished properties are stable, proved by conclusive test data over a ten year period. No special foundry techniques are required. No fluxes. Castability is excellent with sand cast and plaster molds and many permanent molds. Tenzaloy will not "grow," produces corrosion-resistant castings with excellent polishing characteristics and anodizes clear white. Write for Tenzaloy Bulletin No. 103. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

FEDERATED METALS DIVISION OF



ASARCO

AMERICAN SMELTING AND REFINING COMPANY

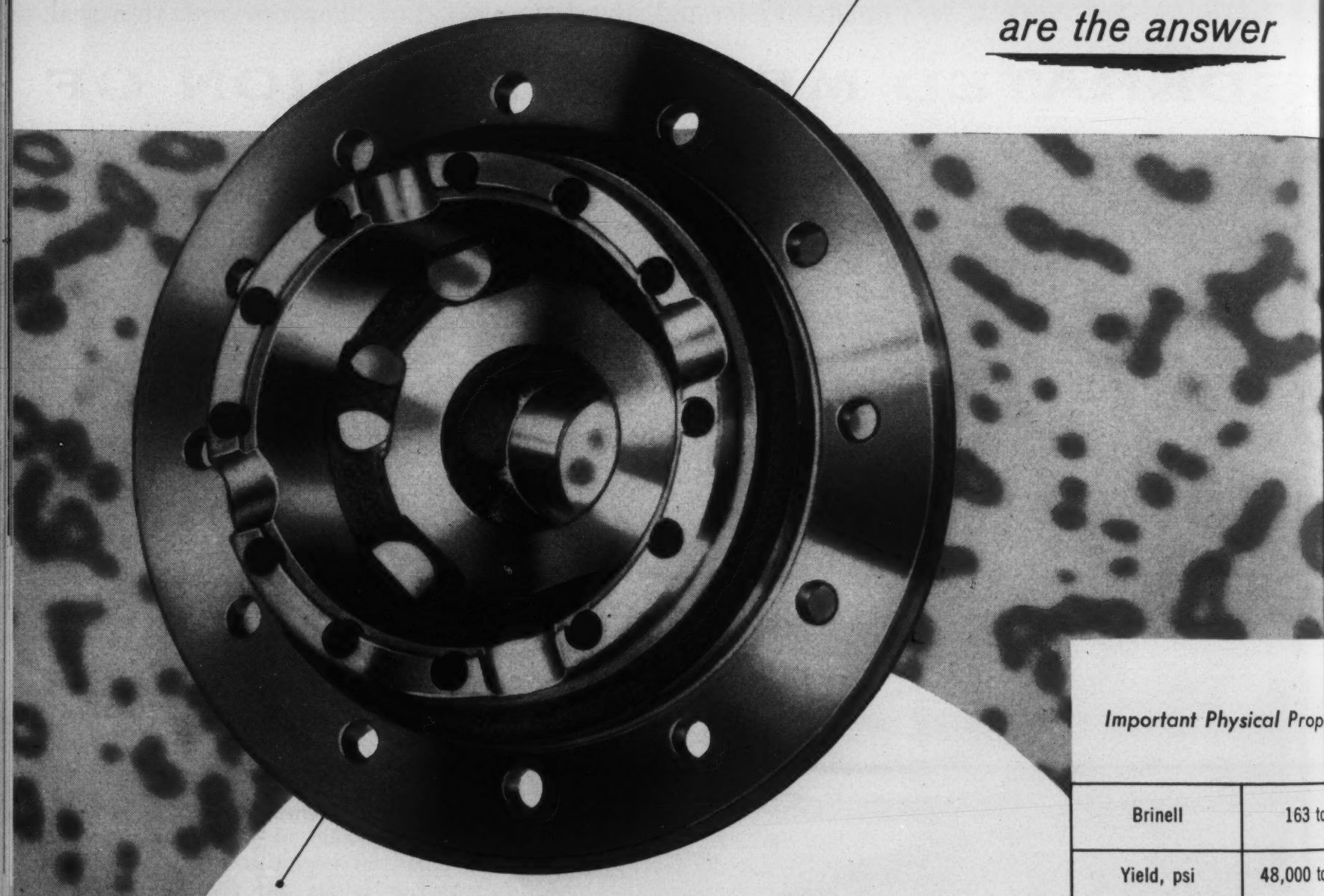
TENZALOY is one of a complete series of Federated aluminum casting alloys. A new plant in Alton, Ill. will soon be in production to satisfy the requirements for Tenzaloy in the mid-west.

is your problem

machinability?

NATIONAL HTM CASTINGS

are the answer



There are many reasons for specifying HTM (Pearlitic Malleable) castings for your product. One is *machinability of 70-90 percent* (B1112 steel = 100).

But there are many other equally valid reasons. High ultimate strength . . . extreme wear resistance under heavy loads and high speeds . . . non-seizing qualities . . . air or liquid quenching . . . ability to be smooth-finished.

So when you're looking over the materials field, don't overlook the advantages of HTM castings. For HTM metal can be cast by either the shell mold, CO_2, or green sand methods. This means production costs tumble . . . performance and saleability of your product go up.

Important Physical Prop	
Brinell	163 to
Yield, psi	48,000 to
Ultimate, psi	70,000 to
Elongation, %	7 to

**Depending upon grad*

NATIONAL MALLEABLE and STEEL **CASTINGS COMPANY**

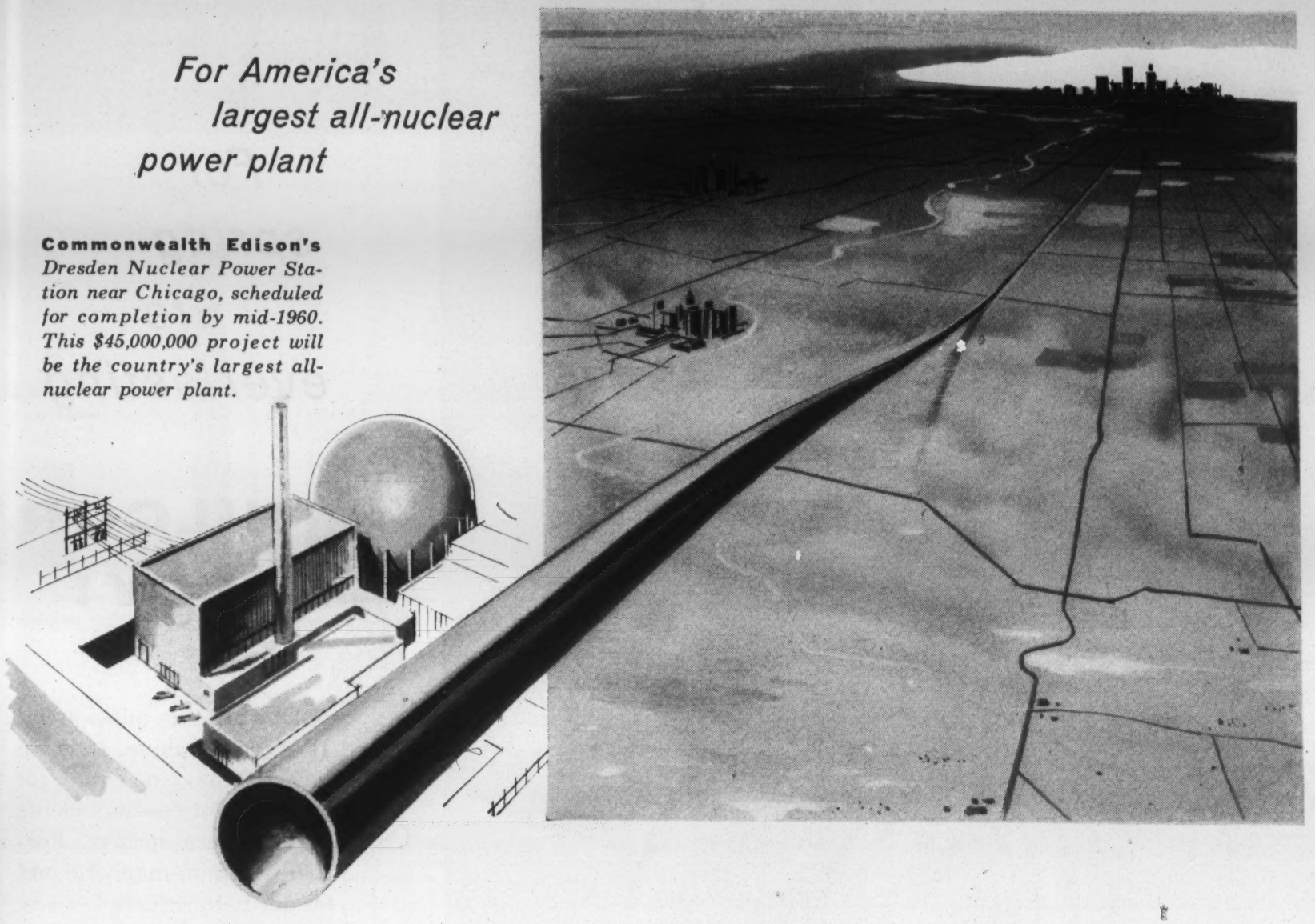
Established 1868 — *Cleveland 6, Ohio*

AA-6832

The nation's largest independent producer of malleable and pearlitic malleable

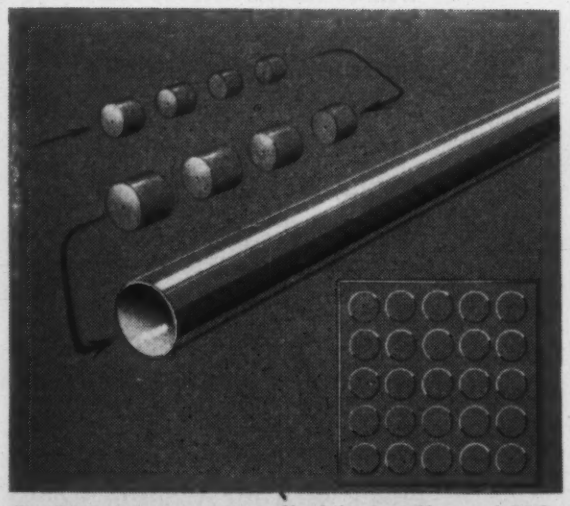
For America's largest all-nuclear power plant

Commonwealth Edison's *Dresden Nuclear Power Station near Chicago, scheduled for completion by mid-1960. This $45,000,000 project will be the country's largest all-nuclear power plant.*



44 MILES OF ZIRCONIUM TUBING

being processed by Mallory-Sharon



To form fuel rods, *cylindrical pellets of UO_2 are inserted in Zircaloy tubing. Tubes are sealed and welded, then assembled into "bundles" to form the rod-type element (inset).*

Here you see a striking example of zirconium's place in nuclear power . . . and of Mallory-Sharon's leadership in zirconium production and technology.

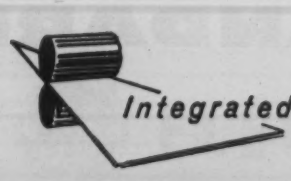
The largest order ever placed for zirconium tubing—almost 44 miles of it—is now being processed by Mallory-Sharon, in conjunction with Bridgeport Brass Co., for the Dresden Nuclear Reactor. Made of reactor-grade Zircaloy-2, 9/16" diameter and 1/32" wall thickness, the tubing must meet rigid tolerances . . . pass special pressure, sonic and corrosion tests. Fabrication of fuel elements is by the Atomic Power Equipment Dept. of General Electric, at San Jose, California, designers and builders of the Dresden Station for Commonwealth Edison.

As the largest integrated producer of zirconium, titanium and special metals, we invite you to write for information on either reactor-grade or commercial grade zirconium. Our Service Engineering group is ready to work with you *now* on either nuclear or commercial applications.

Write for new booklet, *"Technical and Application Data on Zirconium and Hafnium"*.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION • NILES, OHIO



Integrated producer of Titanium • Zirconium • Special Metals

For more information, circle No. 369

For more information, turn to Reader Service card, circle No. 422

For spring life everlasting...

NILCOR* ALLOY!

Nilcor alloy is not a steel! It is truly unique. It is believed to have no equal, for example, for continuous life in miniature springs. Further, it is non-magnetic and far outdistances steel or any known alloy in resistance to "set", fatigue and corrosion . . . even at high temperatures.

Major use to date is for non-breakable power springs in fine watches. But more and more Nilcor alloy is and will be furnished for the most critical requirements in instrumentation, control devices and equipment of many types . . . wherever extreme spring life and precise behavior are vital.

Perhaps National-Standard Nilcor alloy holds promise for some of your needs. We shall certainly be glad to cooperate *all* the way in helping you find out. Just check with our Athenia Steel Div., Clifton, New Jersey.

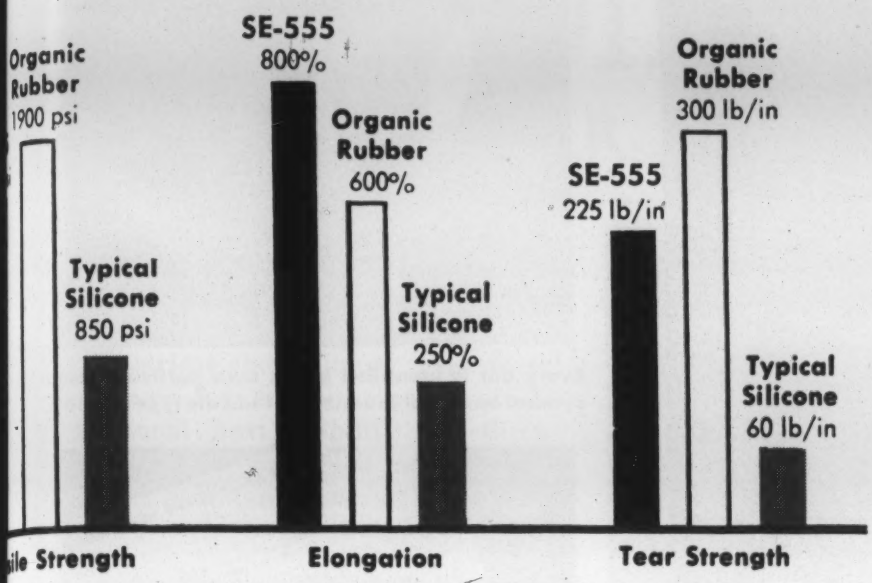
**Trade Mark National-Standard Co.*

NATIONAL NS NATIONAL-STANDARD **STANDARD**

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *tire wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *music spring, stainless and plated wires, high and low carbon specialties* • WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

For more information, turn to Reader Service card, circle No. 383

HOW TO SOLVE PRODUCT DESIGN PROBLEMS WITH GE SILICONE IDEAS

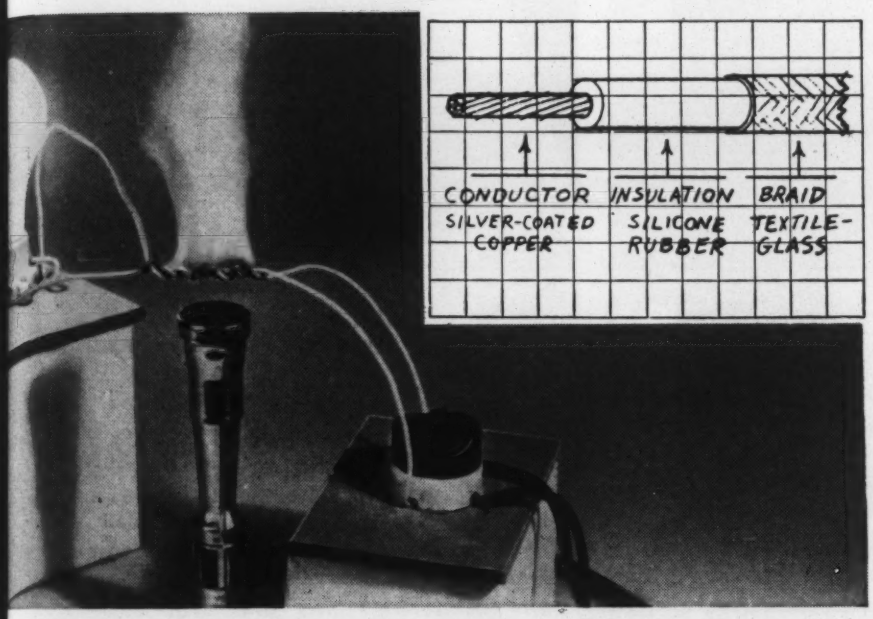


Problem: *Organic rubber parts failing because of temperature extremes and ozone. High tear and tensile strength cannot be sacrificed.*

Solution: Replace with SE-555—silicone rubber with tear and tensile strength comparable to organic rubber.

SE-555 is a new silicone rubber with tear and tensile strength double that of ordinary silicone rubber (see comparative typical values at left). Whenever maximum resistance to weather and temperature extremes (minus 150°F to 500°F) is required, combined with high tear and tensile strength, specify SE-555. This is the only material available to rubber fabricators that meets AMS 3345 requirements for tear and tensile strength, elongation, heat resistance, compression set and low temperature flexibility. SE-555 can be fabricated in practically any color, including white.

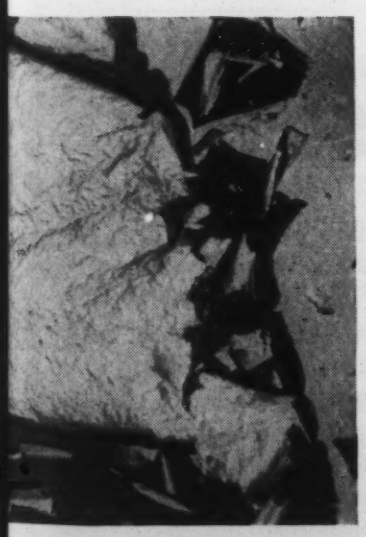
You can order high strength silicone rubber parts immediately because SE-555 is available from stock for shipment to your fabricator. For more information and a list of qualified fabricators, mail the coupon below.



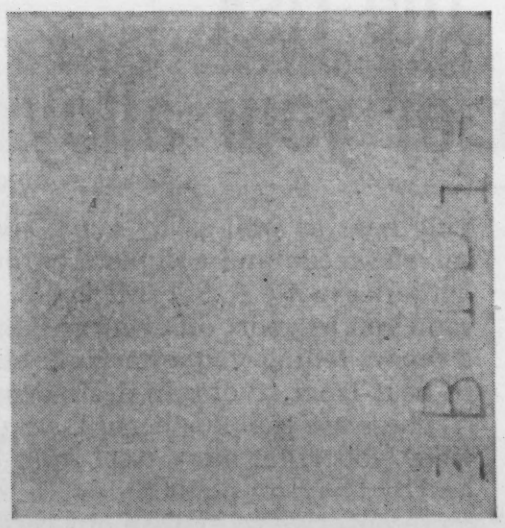
Problem: *Find a wire insulation to withstand extreme conditions of temperature, moisture and ozone.*

Solution: Wire insulated with G-E silicone rubber.

Exposed to an 1800°F flame for hours, G-E silicone rubber insulation forms a non-conducting ash which still insulates. No toxic fumes are released, nor will it shrink and expose the conductor, as the laboratory demonstration on the left shows. Silicone rubber has superior dielectric strength at high temperatures and keeps it for years. It has unparalleled ozone resistance, stays flexible down to minus 75°F or lower. Use silicone rubber insulated wire wherever temperatures are extreme, and where an extra safety margin is needed. Examples: aircraft wire, Class B and H motor and apparatus lead wire, electronic hook-up wire and control cable. Want more information? Send in coupon below.



eel coated with an alkyd alumi-, subjected to 1000°F for 2 hours.



Carbon steel coated with silicone aluminum finish, subjected to 1000°F for 24 hours.

Problem: *Extend the life and appearance of metal surfaces designed for high temperature operation.*

Solution: Special paints made with G-E silicones.

Silicone based paints are finding increased application as corrosion-resistant or appearance-preservation coatings for many metals exposed to continuous temperatures as high as 1000°F. For instance, special aluminum-silicone paints often make it possible to use mild steel instead of stainless steel in industrial applications. High gloss silicone paints have proved to be amazingly durable finishes for heaters, appliances, etc. Gloss and color are retained up to 440°F, and the finish resists marring, scratching and chemical attack more than ordinary paints. Check into the performance advantages of high temperature silicone paints. Special paint formulations have been developed by leading paint manufacturers for specific temperature ranges and applications. For more data, fill in the coupon below.

Write for more information . . .

GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

For more information, circle No. 413

Section D6B6, Silicone Products Dept.
General Electric Company, Waterford, N. Y.

Please send me application data and names of suppliers of:

☐ Silicone rubber mechanical goods
☐ Silicone rubber insulated wire ☐ Silicone based paints

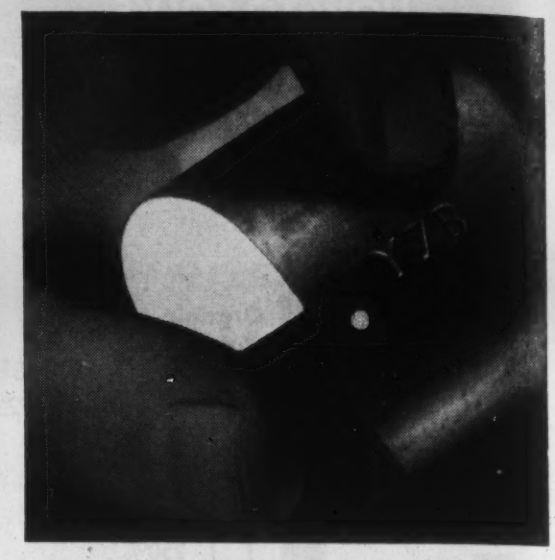
Name_____ **Title**_____

Company_____

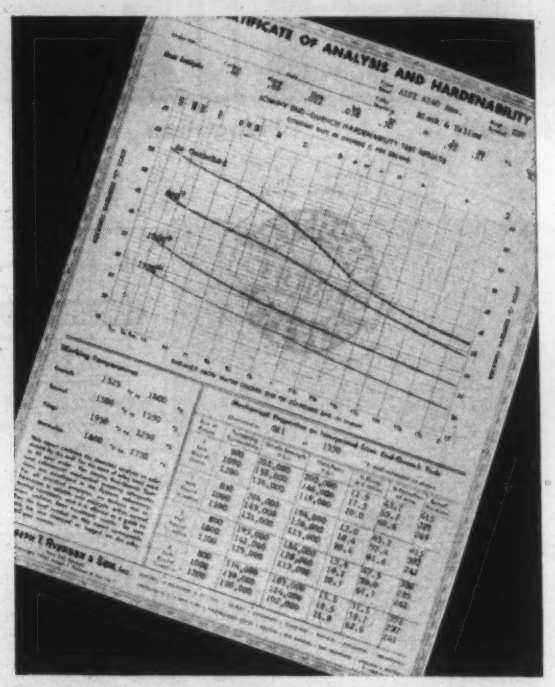
Address_____

City_____ **Zone**_____ **State**_____

Spark testing by skilled Ryerson inspectors protects against possibility of mixed steels.



Every bar is identified by its own particular heat symbol and color marking, to indicate type of alloy.



With every shipment you receive a Certificate of Analysis and Hardenability—your complete record of the steel's characteristics, and your guide to dependable heat treatment.

How Ryerson takes the risk out of your alloy steel

Alloys from different heats can vary widely in hardenability—and as a result, vary just as widely in mechanical properties.

This puts a big question mark on how your steel will perform. Moreover, you may not know you have a problem until it's too late.

The big difference with Ryerson is—you know what to count on before you start. Every bar of Ryerson alloy steel is protected by an 8-Point Quality Control Program—including identification by specific heat as well as by type; spark testing to avoid mixed steels; and complete hardenability tests in accordance with A.S.T.M. specs. This enables us to send you a report on every shipment of alloy steel . . . a report telling you what your steel will do, and how to heat-treat to obtain desired properties.

These are the plus benefits you get at no extra cost when you order alloy steel from Ryerson. Call your nearby Ryerson plant today. . . . or ask your Ryerson representative to explain our certified plan.

RYERSON CERTIFIED QUALITY

RYERSON STEEL

Member of the INLAND Steel Family

Principal products: Carbon, alloy and stainless steel—bars, structurals, plates, sheets, tubing—aluminum, industrial plastics, metalworking machinery, etc.

JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • WALLINGFORD, CONN. • PHILADELPHIA • CHARLOTTE • CINCINNATI • CLEVELAND DETROIT • PITTSBURGH • BUFFALO • INDIANAPOLIS • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • SPOKANE • SEATTLE

For more information, turn to Reader Service card, circle No. 566

DOW CORNING CORPORATION

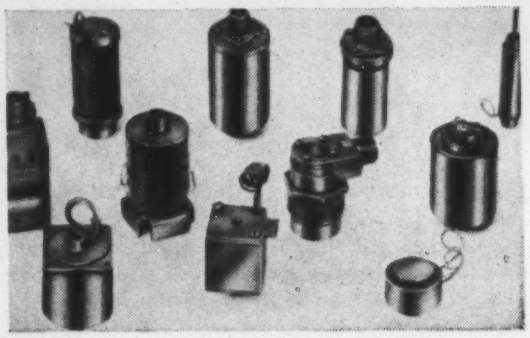
Silicone News

FOR DESIGN ENGINEERS No. 51

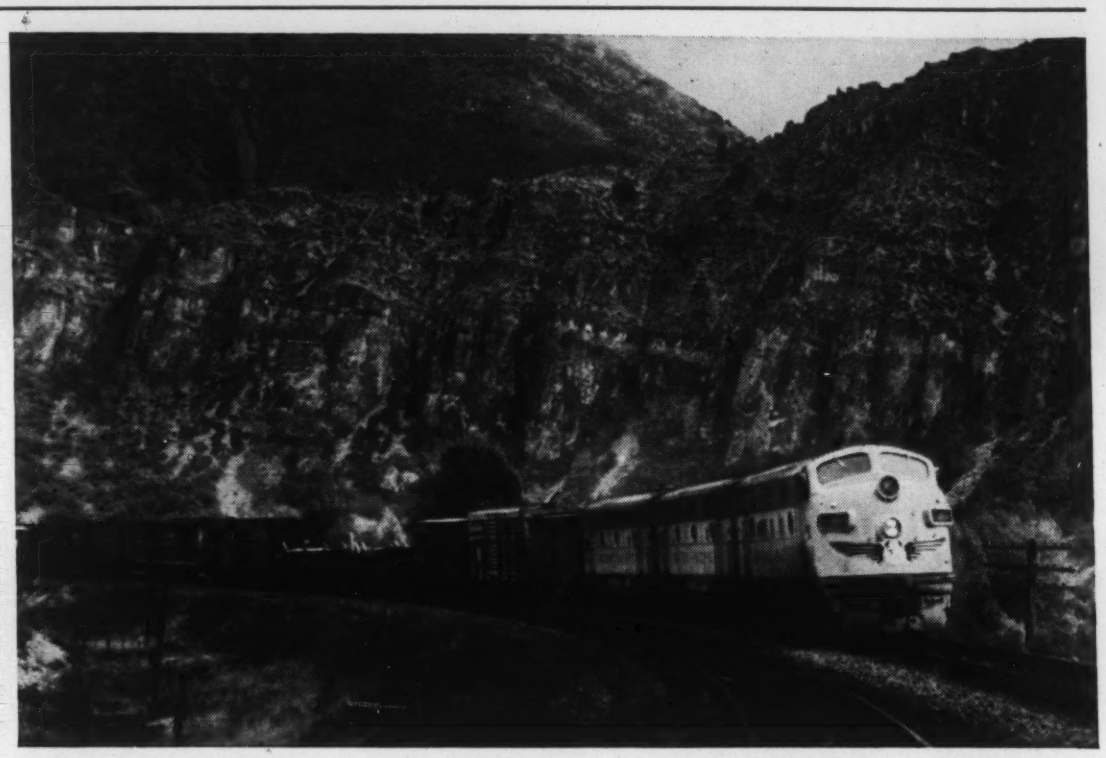
SILICONE INSULATION SURVIVES OVEN FIRE

An electrical short circuit recently set the stage for dramatic proof of the exceptional heat stability of silicone insulation. It happened at American Machine and Manufacturing Co., Union, New Jersey. Here's the story:

American Machine produces a wide selection of miniature coils for the aircraft and electronic industries. These coils are insulated with Dow Corning Silicones to save weight and space and to assure their reliability at ambient temperatures in the range of 350 F.



While curing 800 of these units recently, an electrical short circuit caused the oven to catch fire. The oven got so hot that the thermometer *(Cont. Pg. 2)*



SILASTIC-GLASS CLOTH HOSE LASTS AT LEAST 8 TIMES LONGER

Under similar high-temperature conditions, how much longer service life can be expected of a Silastic-glass cloth hose than from a conventional rubber-cotton hose? Answer: at least 8 times longer, according to the developers of this new hose, Hewitt-Robbins of Stamford, Connecticut.

This heat-stable Hewitt - Robbins hose comprises 5 plies of glass cloth sandwiched in Silastic*, the Dow Corning silicone rubber. Both inner-liner and cover are solid Silastic. Burst strength of the hose is estimated at better than 600 psi.

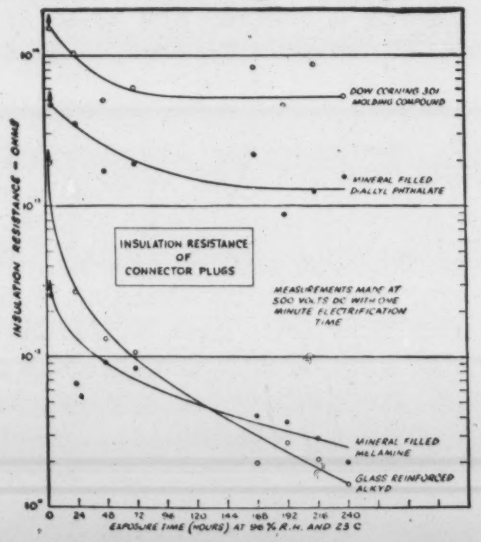
Now in use as radiator couplings for diesel locomotives of Union Pacific, Silastic-glass hoses carry "coolant" as hot as 230 F on the inside, while the outside is exposed to engine compartment heat. They are also subject to constant vibration. Whereas organic rubber-cotton hoses lasted about 3 months in this application, Silastic-glass hoses have already been in service over 24 months and are still in excellent condition. *No. 516*

*T. M. REG. U. S. PAT. OFF.

Even 1000 F Can't Distort Silicone Molding Compound

Three years of research have convinced engineers at Olympic Plastics Company, Inc., Los Angeles, that no other plastic-like material equals silicone molding compound in insulating efficiency or heat stability. Proof is the performance of Olympic's new terminal strip assembly which has been adopted as a National Aircraft Standard.

Molded from a Dow Corning silicone molding compound, this terminal strip shows no sign of heat distorion after 100 hours exposure to 1000 F, a temperature high enough to disintegrate even the best organic plastics.

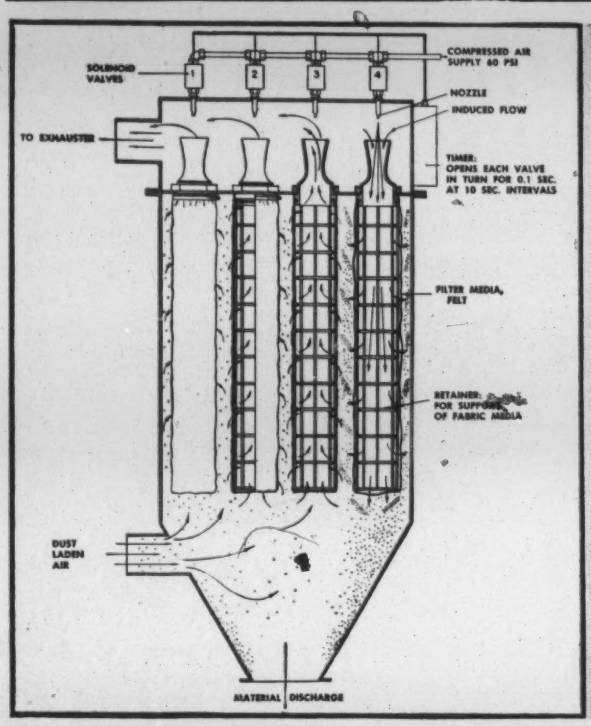


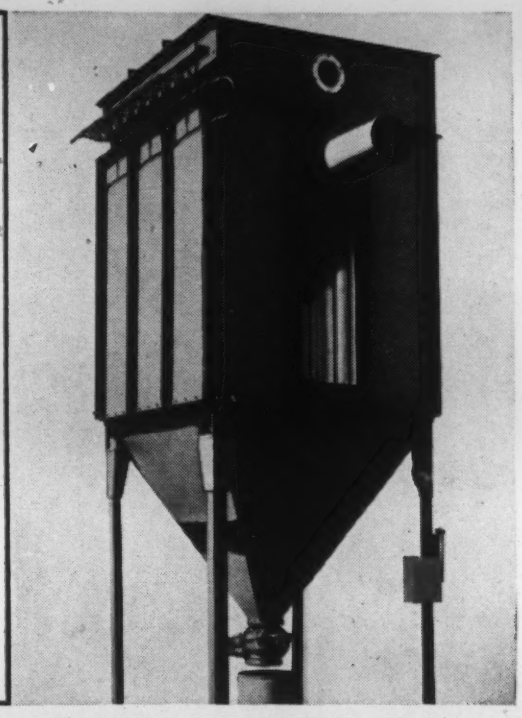
Recommended for continuous duty at 600 F, the Olympic terminal strip completely eliminates arcing at high altitudes —a major weakness of boards made from other materials. That's why it has been adopted by North American *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE MORE

DOW CORNING CORPORATION

Silicone News





A "SLICK" TRICK WITH SILICONES

Plagued with the problem of dust particles plugging wool-felt filters, engineers at Pulverizing Machine Division of Metals Disintegrating Co., Summit, New Jersey, specified Dow Corning 200 Fluid as a release coating. Result: Increased efficiency and service life for their new "Mikro-Pulsaire" dust collector.

Designed to "clean" the atmosphere in plants processing materials such as powdered gypsum, copper, cement and sugar, this unit employs a 1-second reverse jet of air every 10 seconds to keep its wool-felt filters from clogging. Designers have found that a coating of Dow Corning 200 Fluid reduces adhesion of dust to wool-felt fibers. This helps immeasurably to increase the life of filters, and increases the unit's efficiency rating to 99.997% on most materials.

As an additional feature, each filter is gasketed with Silastic*, the heat-stable Dow Corning silicone rubber, to provide a positive seal and make the units operational at temperatures as high as 390 F. Mikro-Pulsaire dust collectors clean 5 to 15 cubic feet of air per minute when the atmosphere is "loaded" with up to 1000 grains of dust per cubic foot. *No. 517*

*T.M. REG. U.S. PAT. OFF.

OVEN FIRE *(Cont.)*

literally burned up after recording 640 F. What's more, all the die-cast aluminum parts of the oven melted before the blaze could be extinguished by the municipal fire department.

To the surprise of inspectors, rigid testing revealed that 797 of the original 800 silicone-insulated coils survived the fire in perfect condition! Heat stability like this makes it possible for silicone-insulated motors, generators and transformers to withstand overloads and ambients that would quickly burn out equipment insulated with other materials. *No. 518*

1000 F TERMINAL STRIP *(Cont.)*

Aviation, Chance-Vought, Northrop, Lockheed and other major aircraft companies.

Using the same silicone molding compound, Olympic Plastics Company manufactures many other types of specialized terminal strips for applications where high temperature resistance and excellent electrical properties are required. *No. 519*

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

Specify Silicone insulated Motors and Transformers and Save is the subject of a new 8-page brochure that cites the many advantages provided in silicone-insulated equipment. *No. 520*

Silicone Coating for paper and paperboard aids packagers and processors of sticky materials — it keeps gummy and tacky materials from sticking to all types of bags, boxes, innerliners, wrappings and interleaving sheets — it will not migrate nor contaminate goods in contact with it. Send for informative brochure containing sample papers. *No. 521*

To Improve Surface Resistivity of printed circuits and electronic equipment under conditions of high humidity, Dow Corning 991 Varnish has been found to be most effective. *No. 522*

Pressure-sensitive Silicone Tapes — that stick to wet or dry surfaces; form good bonds; have high dielectric strength; repel moisture; are not affected by corrosive chemicals — are described in a folder designed to help you choose the tape best suited to your application. *No. 523*

"Rubber from Rock," a new color-sound movie, explains how Silastic, the Dow Corning silicone rubber, is manufactured from quartzite. Demonstrates why parts fabricated from Silastic retain rubber-like properties from —130 to over 500 F in a wide variety of military and industrial applications. Also covers uses for Silastic as a dielectric in electronic and electrical equipment. To arrange for a showing of "Rubber From Rock" in your plant, circle *No. 524*

1958 Guide to Dow Corning Silicones — consists of 16 pages filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones. Cross indexed for handy reference, this all-new Guide includes properties and uses for the silicone products developed in recent months. *No. 525*

Dow Corning Corporation, Dept. 706, Midland, Michigan

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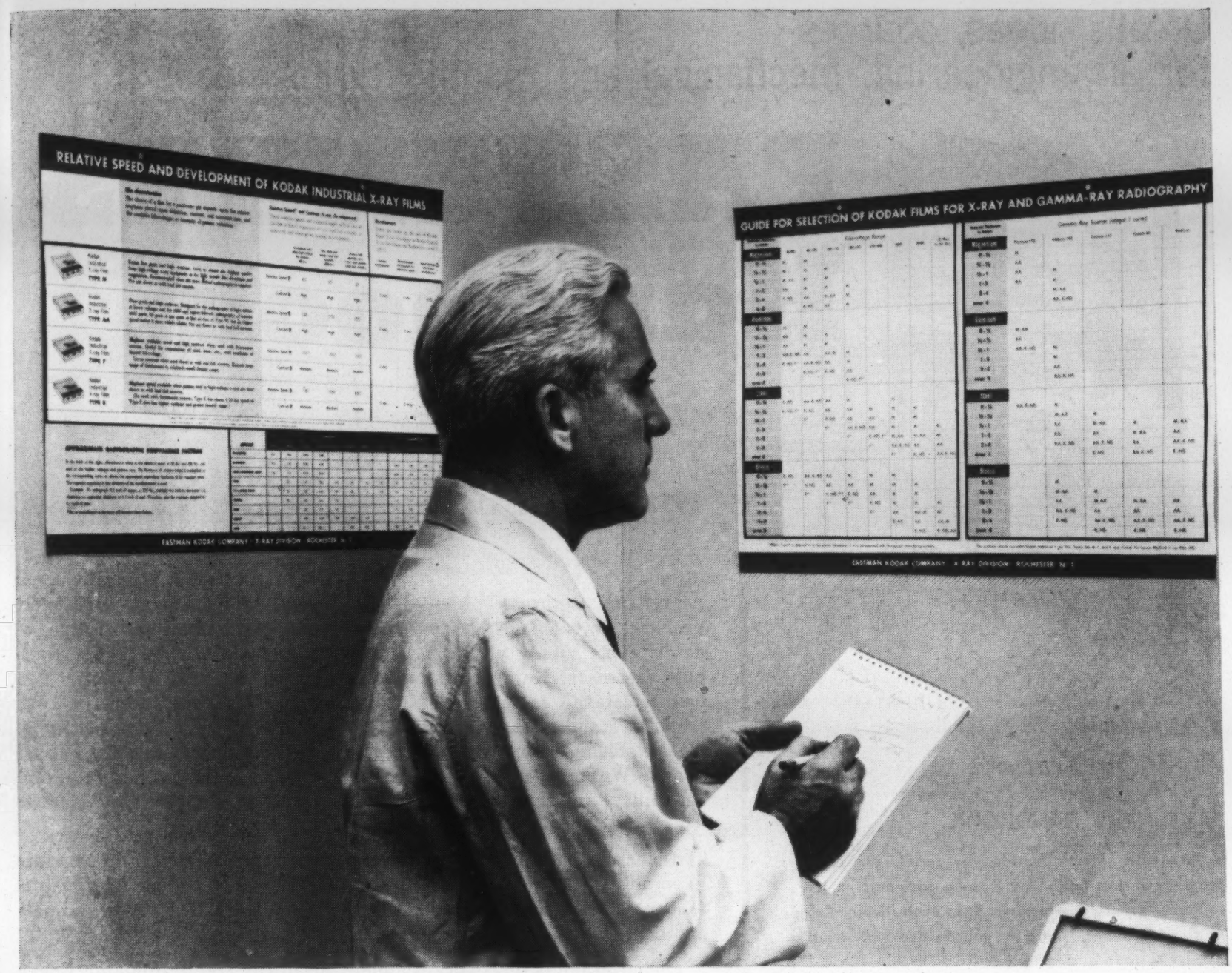

Important Radiographic data at a glance

Free Wall Charts give you latest information on film selection, relative speed, and contrast.

TODAY'S fast films and varied radiation sources give the present-day radiographer many new opportunities for establishing exposure factors to meet unusual conditions and get better radiographs.

So that you can have the latest information right before you, Kodak has prepared two quick-reference wall charts—one, a guide for selecting the best type film for your x-ray and gamma ray work—the other, showing relative speed, contrast, and development of Kodak Industrial X-ray Films.

These charts are yours—free for the asking. Just drop us a line and you'll get yours by return mail.

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54-6

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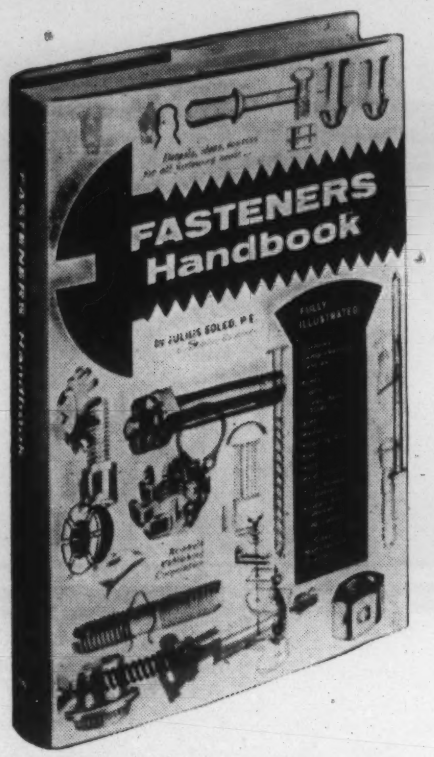
Details, ideas, sources
for all engineering, mechanical and manufacturing needs



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Standard Nuts; Free-Spinning Locknuts; Prevailing-Torque Locknuts; Nonlocking Nuts.

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MANUFACTURERS DIRECTORY

FASTENERS HANDBOOK provides ready, up-to-date answers to fastener problems in all fields. Its pertinent data, illustrations, and full page descriptions supply you with detailed information on currently available fasteners. Here is a *handbook* in every sense of the word. You can *select* the fastener you want because this comprehensive book includes standard and proprietary fasteners from all manufacturers. These include the many specialized fasteners developed since the Second World War; specific fasteners that increase structural safety and reliability; and the whole range of sizes and type of materials available.

This is the *only* fastener reference which relates the actual uses of fasteners in one industry to those of another. The result is concrete examples of money-saving applications for all designers and manufacturers. The book also points out the plus values of many less known but equally valuable fasteners.

The coverage is unusually complete, accurate, and up-to-date. Every description of a proprietary fastener has been verified by its manufacturer. All major manufacturers and most smaller ones have supplied material. The industry associations such as the Fasteners Institute and the Screw Bureaus have likewise contributed.

Fastener development has far exceeded the published information on fasteners. This handbook meets the tremendous need for a reliable, current, and authoritative reference to fasteners and fastener resources.

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send —

- cross-sectional sketch of drawing and dimensional tolerances
- length of strip and tolerances
- material specifications
- permissible edge curvature and flatness
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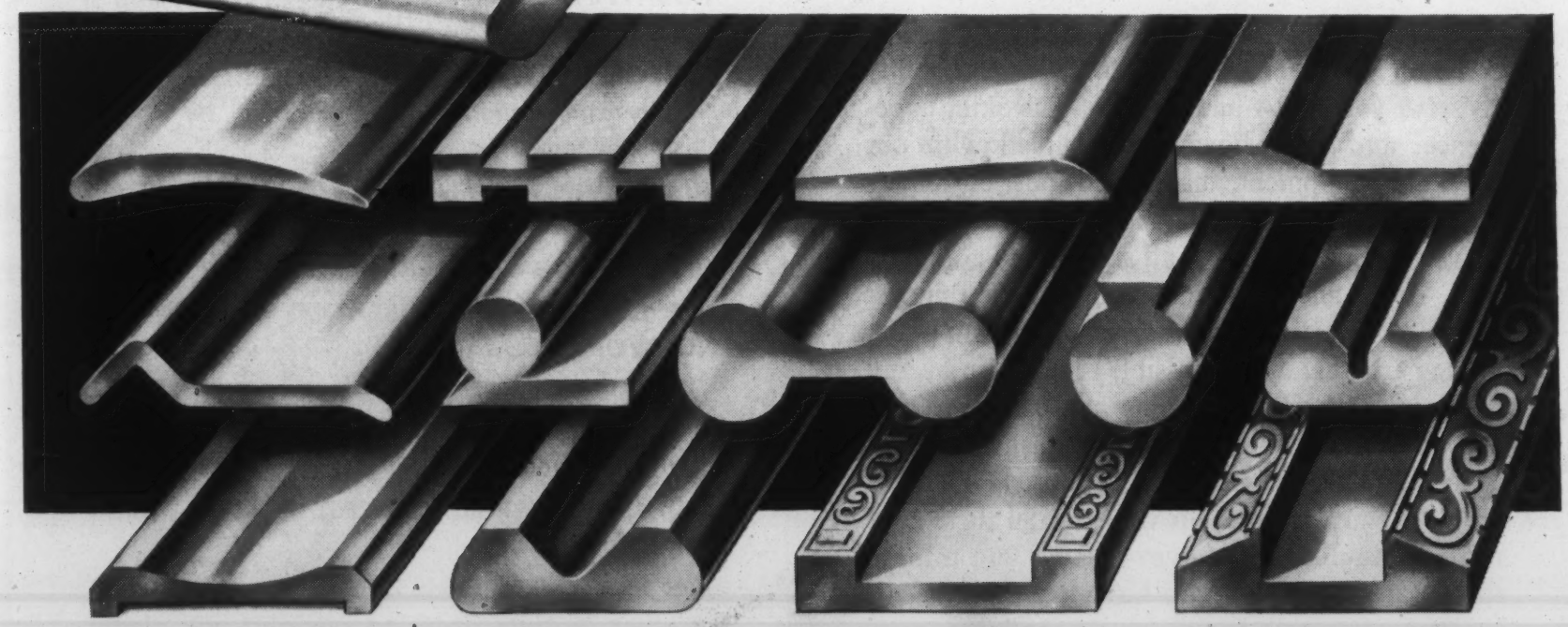
- quantities involved.



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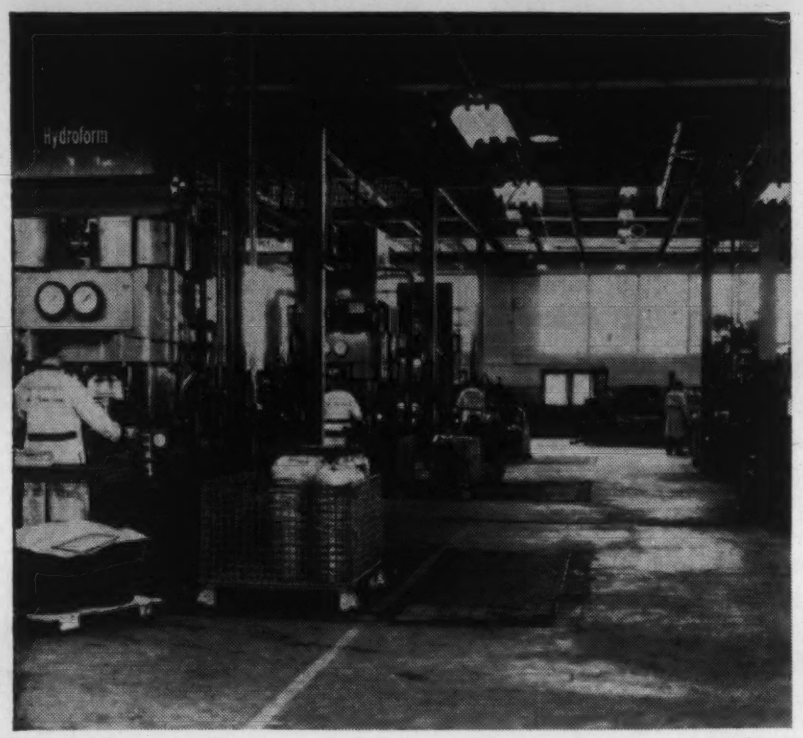

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We can make parts of all shapes and complexities—from all ductile metals. From the thinnest sheets to 5/8" steel plate and 7/8" aluminum plate. Some parts that are impossible to produce by any other method. Hydroforming can often produce spectacular results in forming prefinished parts—reducing delivery times—cutting costs. One manufacturer **cut production time by 90 days and reduced tooling costs over $30,000.00** on three small parts alone. **Do you have a part that can be Hydroformed?** It will pay you to investigate.

Write, wire or call for details, or send your prints for estimates — in strictest confidence of course.

Hydroforming Co. of America

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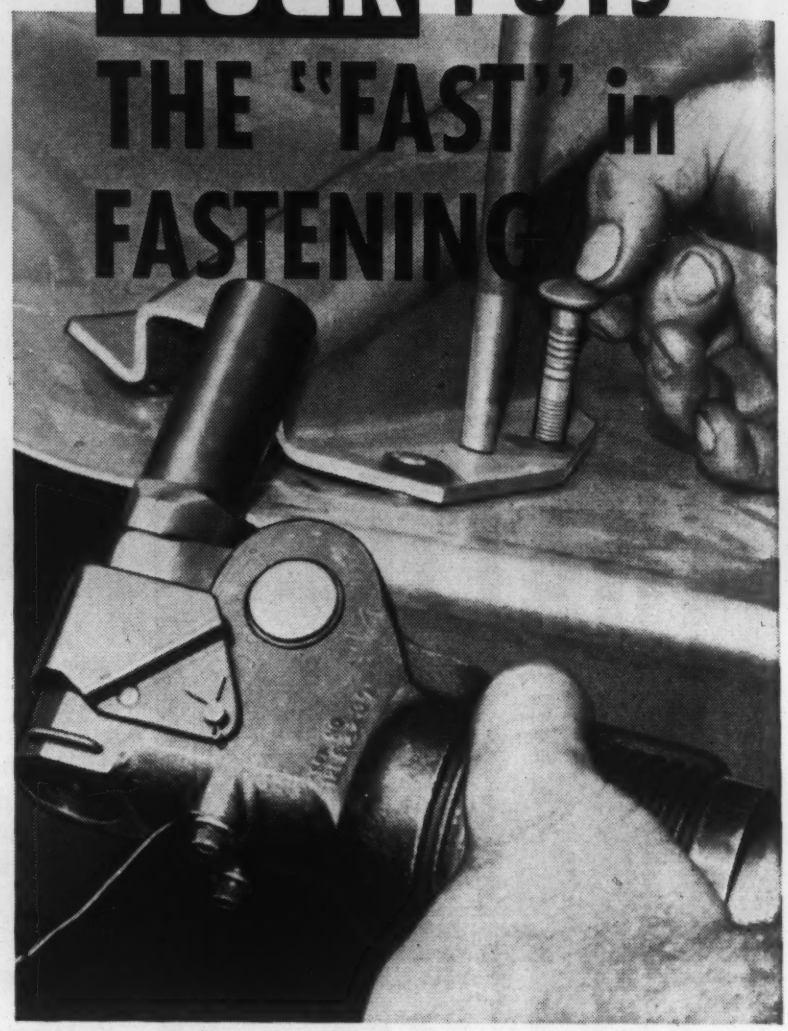
HUCK PUTS THE "FAST" in FASTENING



Whether you are interested in fasteners that will hold permanently "fast" or are "fast" to install, HUCK gives you both.

Nowhere can you find so many desirable features as you'll get with HUCK FASTeners.

POSITIVE MECHANICAL LOCK—can't slip, strip or wear loose.

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EASILY REMOVED—Simple tools afford fast removal without damage to product.

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Treatment with Parkerizing builds a protective coat of non-metallic phosphate over all surfaces of the metal, barring corrosive forces. This resistant coating may be waxed, stained, oiled or painted.

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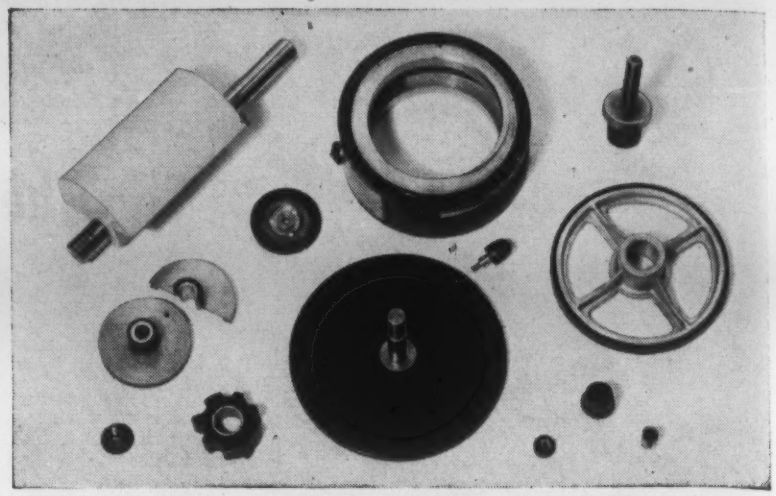

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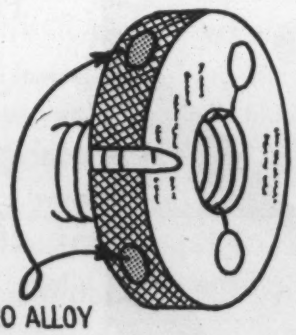

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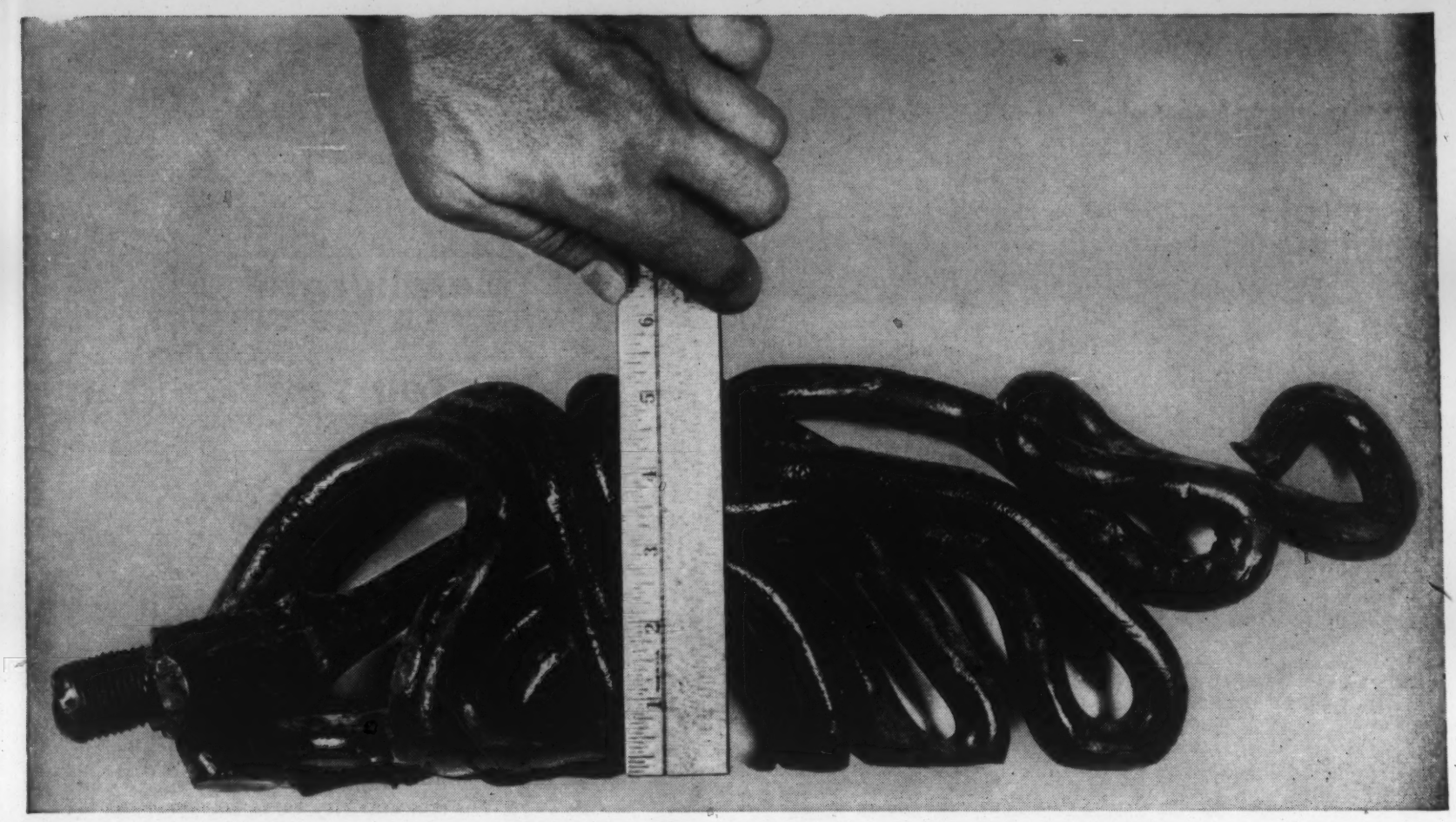

This steel "pretzel" was 14 feet long!

Down near Caprock, New Mexico, they're still talking about it . . . the nickel alloy steel sucker rod that squashed into 18 inches.

It took an accident to demonstrate real toughness.

The sucker rod, a long shaft connecting power at the surface with a piston thousands of feet below, was operating rhythmically. Its reciprocal motion brought up oil in rich spurts.

Suddenly, part way down, the well casing broke, trapping the sucker rod. Fourteen feet of rod were quickly crammed into 18 inches. But despite violent twists the sucker rod *didn't break!* See for yourself!

Nickel alloy steel provides toughness... plus fatigue resistance

Stresses on sucker rods from the pumping motion are high, and fatigue life must be extended as far as possible even in corrosive wells. That's why this one was made of AISI 4820 steel – a high-strength nickel alloy steel containing 3.5% nickel and .25% molybdenum.

It's a quenched and tempered steel. Normally a carburizing grade, 4820 specially quenched and tempered gives excellent toughness along with through hardness and relatively high strength.

Typical mechanical properties are:

Ultimate strength	120,000 psi
Yield strength	110,000 psi
Elongation	25% in 4 x diam.
Reduction of area	68%
Brinell hardness	241
Izod impact	90 ft. lbs.

We don't know of many better illustrations of the toughness and ductility of high strength nickel alloy steels than this one.

At any rate, down near Caprock, New Mexico, they're still talking about it.

If you'd like to know more about high mechanical properties of Nickel Alloys Steels . . . their strength, toughness, ductility and resistance to corrosion fatigue, for example, send for "The Properties of Heat Treated Wrought Nickel Alloy Steels."

The INTERNATIONAL NICKEL COMPANY, Inc.
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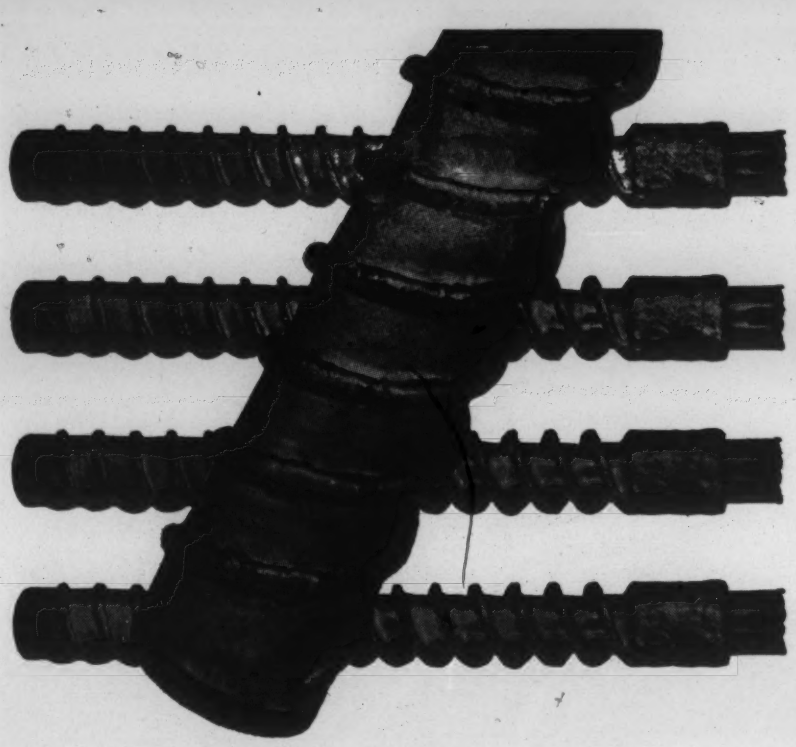
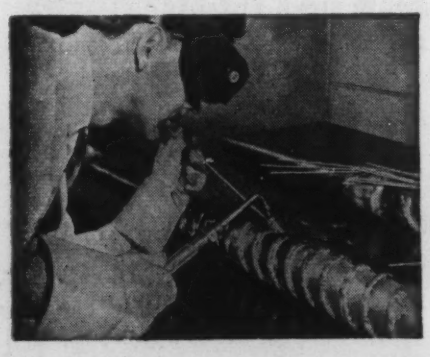


Colmonoy INCREASES Extrusion Screw Life

Tests revealed a tremendous increase in the service life of these Colmonoy hard-faced extrusion screws, as against the unprotected screws usually used. Orders for new replacements now specify Colmonoy hard-facing.

Used for extruding plastic, these screws are made of age-hardening nickel-base alloy. This alloy is now readily hard-faced with little loss of hardness, using Colmonoy No. 6 gas rod and a new Colmonoy high temperature flux.



The 60-inch screws have a .050" overlay of Colmonoy No. 6 when finish ground. Colmonoy hard-facing pays for itself in increased life very quickly on expensive parts such as these.

To provide any metal part with longer life, investigate Colmonoy alloys and methods. They represent a complete line of wear resistant alloys and the most up-to-date in hard-facing techniques.

Submit part drawings and a description of the wear encountered for a specific recommendation. Request Hard-Facing Manual No. 79.

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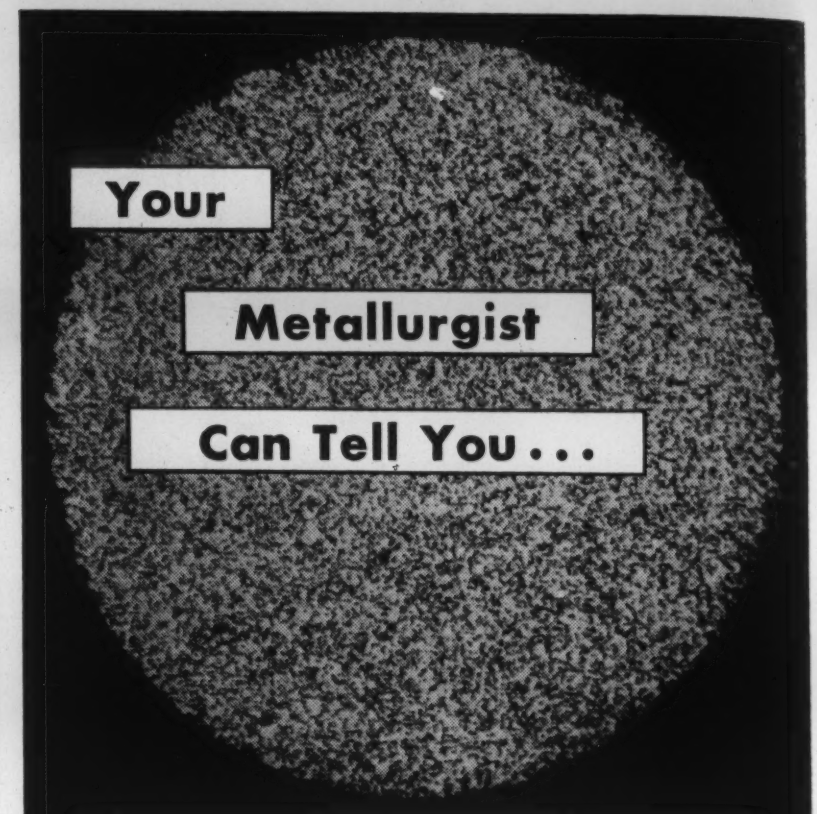

... why Webb works where others won't. A lot of the answer is in this photomicrograph of Webb Needle Wire. The concentricity, complete spheroidization and freedom from decarburization shown above spell big fabrication and performance benefits for you.

WEBB WIRE Division of The CARPENTER STEEL CO New Brunswick, N. J.

WHO WHEN WHY

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is it smart business to order from WLS?

are more smart manufacturers using WLS?

This illustration (approx. 1/2 actual size) of an actual part produced by SPEEDTOOLING for one of our customers represented a savings of 89% over previous production methods.

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- Tapping
- Countersinking
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WHO — Over the years, more and more manufacturers who have been paying high tooling and labor charges and have been receiving slow delivery schedules have found that WLS SPEEDTOOLING has given them large savings and fast delivery every time!

WHEN — If your stamping quantities are within 100,000 and your tolerance requirements are within ±.001" look to WLS to meet your requirements. However, there are many cases in which runs are higher and tolerances even closer.

WHY — In today's hotly competitive manufacturing field, it's just smart business to get the most from your money, and, remember — WLS is an established firm, familiar with every phase of designing and engineering short run stampings.

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FOR THOSE MANUFACTURERS WHO ARE FACED WITH MANUFACTURING PROBLEMS WE OFFER A FREE BULLETIN ILLUSTRATING MANY STAMPINGS WE HAVE PRODUCED FOR MANUFACTURERS AS WELL AS A SAMPLE AND COST SUMMARY OF AN ACTUAL PART. WE ALSO OFFER FREE QUOTATIONS FROM YOUR BLUEPRINTS AT ANY TIME.

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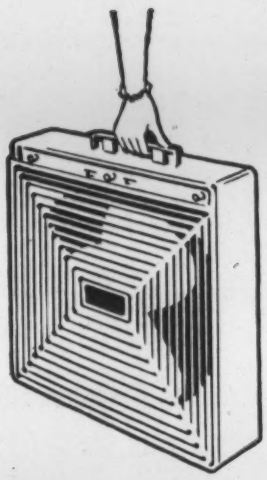

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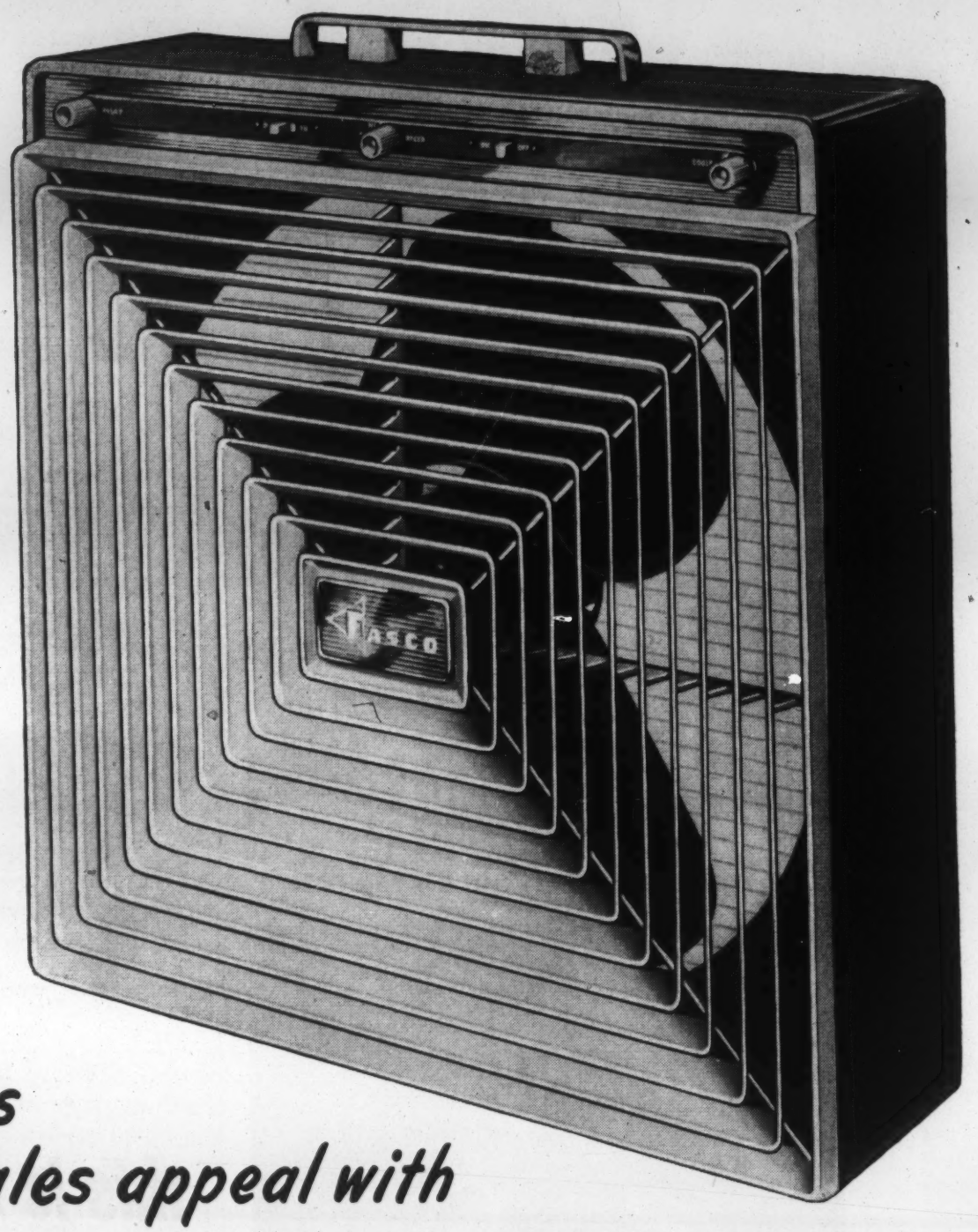

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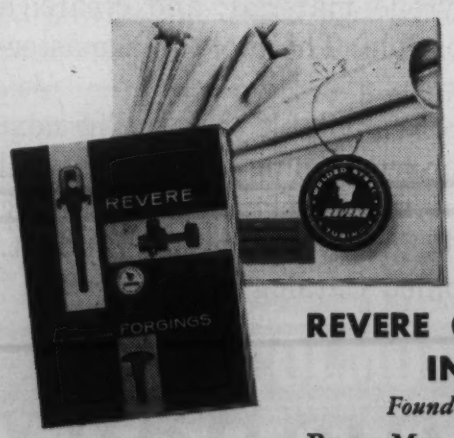

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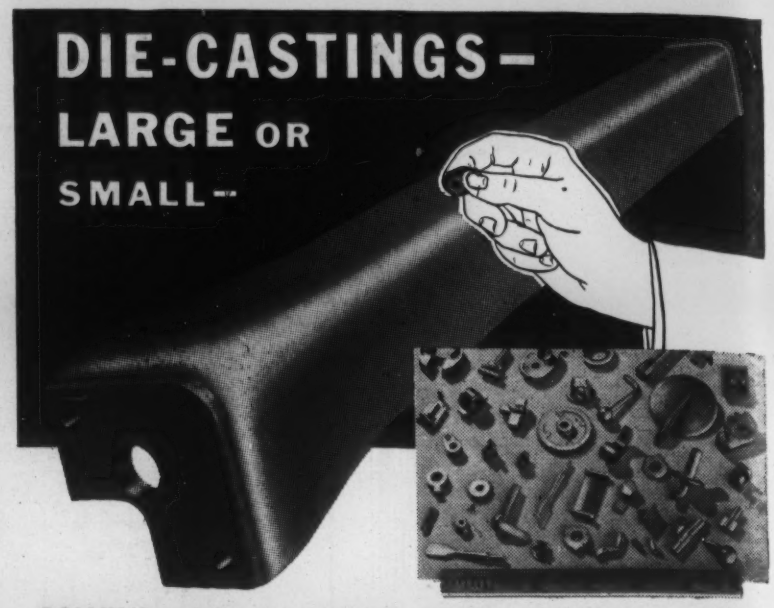

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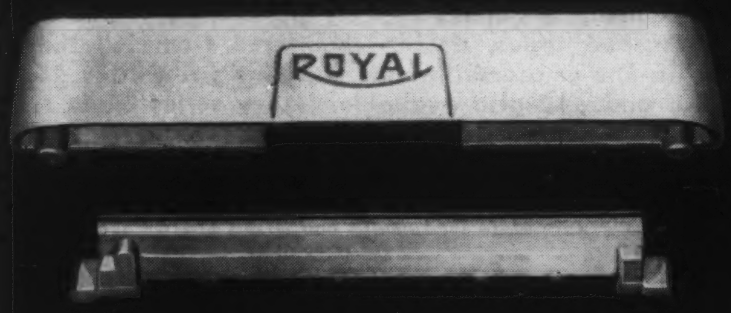

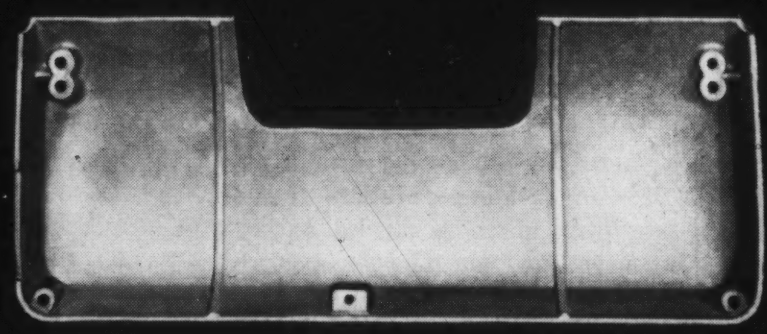

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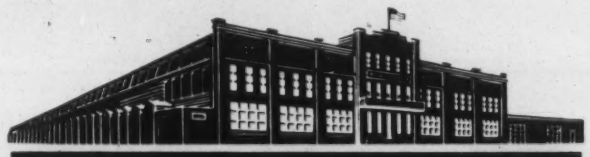

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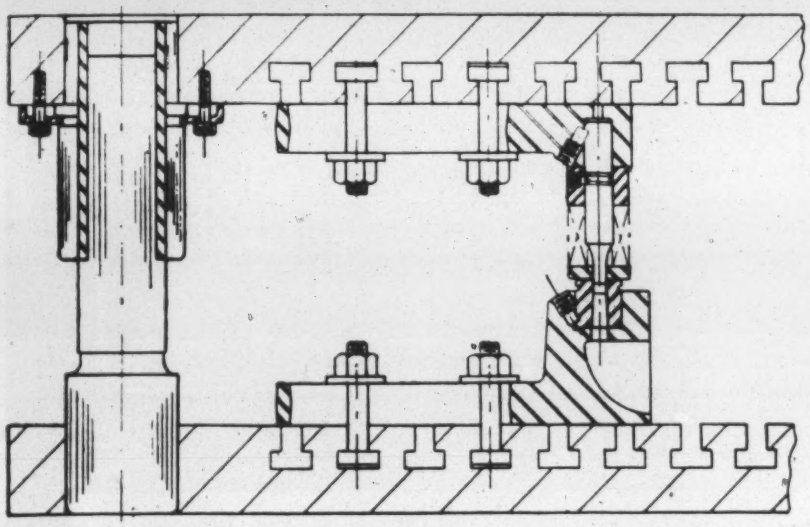
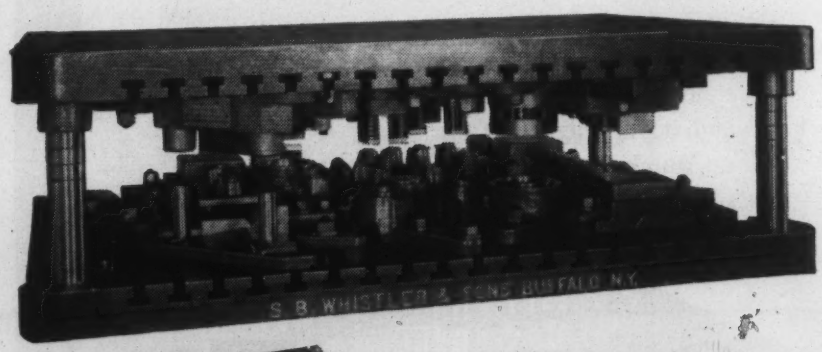
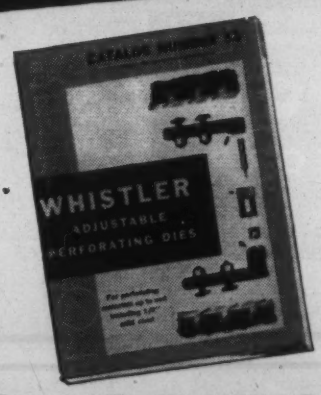


Above: Sectional drawing of a Whistler adjustable punch and die unit assembled in T-slot die set. **Below:** A completely assembled Whistler adjustable die ready for the press.





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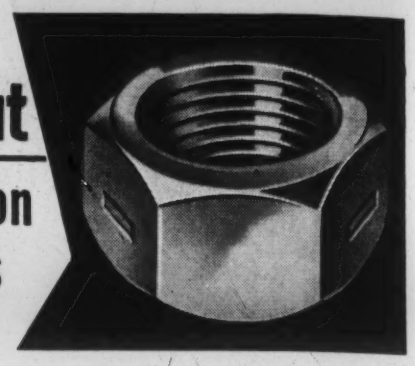

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Chemical Prepaint Treatments for Metal Surfaces

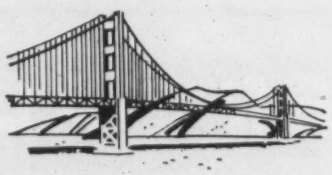
What they do, the types available, how they are applied

By J. H. GEYER
Manager, Product Development Dept.,
AMERICAN CHEMICAL PAINT COMPANY

Paint systems have been steadily improved in an effort to produce more decorative, easier-to-apply, and more corrosion-resistant films. The ability, however, of any paint film to perform its predetermined functions cannot be fully utilized without properly preparing the metal surface.

The prepaint preparation of the metal surface is therefore a highly important part of the system. Chemical prepaint treatments are designed to do four jobs and do them well. First, they remove organic soils, shop dirt, scale, and rust or corrosion products from the metal surface. Second, they provide surfaces that are completely compatible with subsequent paint films. Third, they produce a *tooth* that promotes good paint film adhesion. Fourth, they effectively prevent underpaint corrosion growth after any breakthrough in the paint film.

Basically, there are four types of chemical prepaint treatments. These are phosphoric acid, iron phosphate, zinc phosphate, and amorphous phosphate or chromate. Each is discussed briefly in the following paragraphs.



Phosphoric Acid

Perhaps the most widely used and certainly one of the most economical chemical prepaint treatments is the phosphoric acid cleaner combination materials. ACP Deoxidine® is such a material. It removes organic soils, rust, scale and contaminating elements from the metal surface. It also produces a light etch on steel, aluminum or zinc surfaces which considerably aids in increasing paint adhesion. It does not, however, form an actual coating on the metal surface. Any breakthrough in the subsequent paint film will permit underfilm corrosion to proceed. Grades of Deoxidine are available for application by brush or swab, hot and cold dip, or hot spray.

Iron Phosphate

Iron phosphating processes are extensively used in the chemical prepaint treatment of appliances such as water heater shells, ranges, washers, dryers and other *white lines*. These processes will produce excellent paint-bonding films on the metal and retard or prevent underpaint corrosion. Duridine,® ACP's iron phosphating process, is a combination organic soil cleaner and iron phosphate coating material. Both the cleaning and coating operations take place in the same bath. Duridine and other iron phosphates do not lend themselves to brush-on application, are primarily designed for spray type equipment of four or five stages. But several dip installations are successfully operating today by inclusion of an alkali precleaning stage.

Zinc Phosphate

ACP Granodine® is an example of this type of chemical prepaint treatment process, the type now being used to treat steel in the automotive industry, and predominantly specified for steel ordnance and military items. This process forms a coating which offers the ultimate in paint adhesion promotion and vastly augments the corrosion resistance of subsequent paint films. Zinc phosphate materials are extremely flexible as to method of application—can be applied by brush, dip or automatic spray equipment. In a typical dip or power spray system, the stages would be alkali clean, water rinse, zinc phosphate treatment, water rinse, and acidulated final rinse. If the metal has considerable areas of rust or scale, an acid pickle is advisable following the alkali cleaning stage.

On zinc surfaces, the zinc phosphates perform a rather unique function. They act as a barrier against chemical reaction between the applied paint film and the zinc surface. This effectively prevents blistering of the paint and early breakdown of the film. This is in addition, of course, to the improvement of paint adhesion and the retarding of underpaint corrosion. ACP Lithoform® is specially designed for use over zinc surfaces and finds wide application as a prepaint treatment for ornamental zinc die castings, refrigerator liners, and on most galvanized work requiring painted finishes.

Amorphous Phosphate and Chromate

These coatings are the films produced by the ACP Alodine processes and similar ones on aluminum surfaces. They have met with wide acceptance in the prepaint treatment of venetian blind strips, refrigerator liners, aluminum heat transfer units, aircraft sheet metal assemblies, and many other items fabricated from aluminum. The various coatings provide an excellent film for the promotion of paint adhesion and effectively prevent underfilm corrosion. As in the case of zinc, aluminum exhibits a tendency to chemically react with some paint systems. The Alodine processes develop a barrier film between the paint and the aluminum surfaces which prevents this reaction. The Alodines are extremely versatile materials that can be applied to aluminum surfaces by brush, hand spray, dipping, mechanical spraying, or roller coating equipment. Brush application is particularly well adapted to the processing of parts too large for simple dip systems or in manufacturing operations that do not warrant a tank setup. In dip, spray or roller coating application, the system usually consists of an alkaline preclean, a water rinse, the Alodine treatment, a water rinse, and an acidulated final rinse. Where the surface is heavily oxidized, a deoxidizer in the line is needed.

The major chemical prepaint treatments for metals have been covered briefly in this article. More complete information can be had by contacting an ACP sales representative or by writing us at Ambler, Pa.

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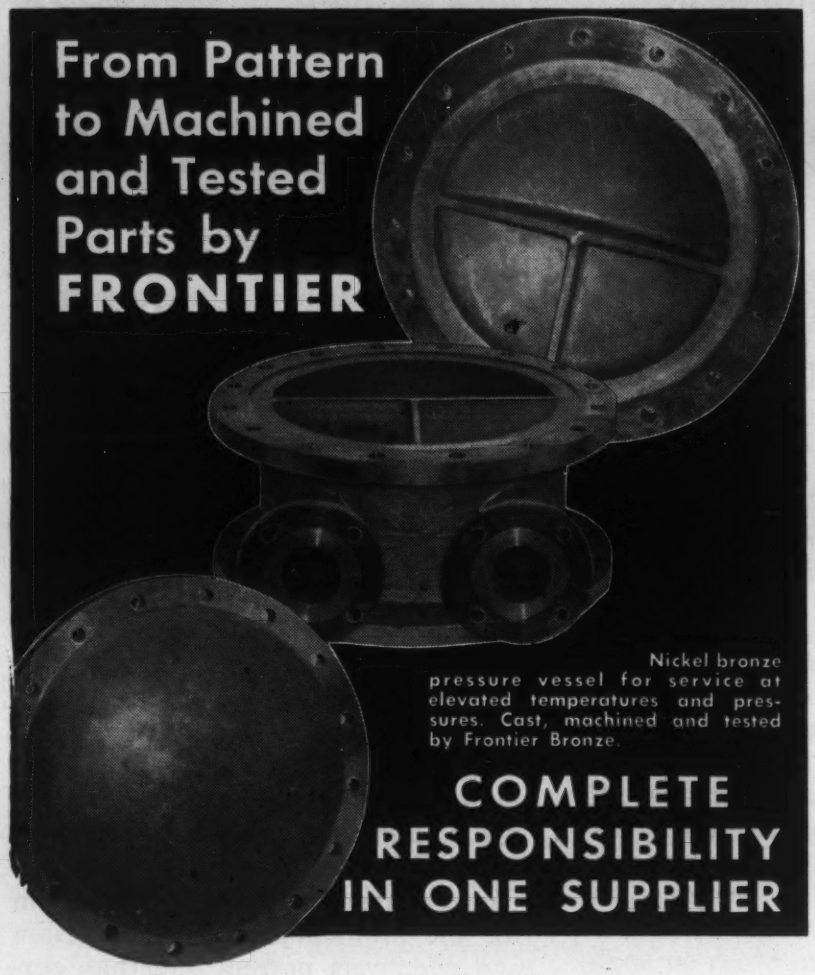

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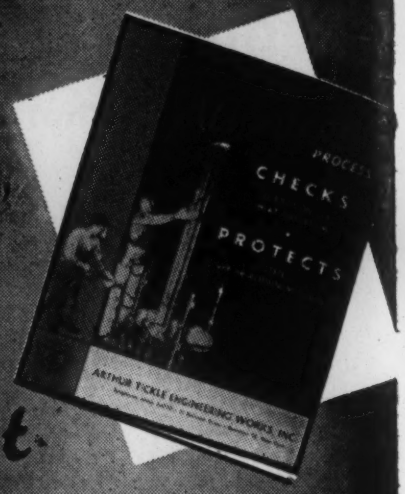

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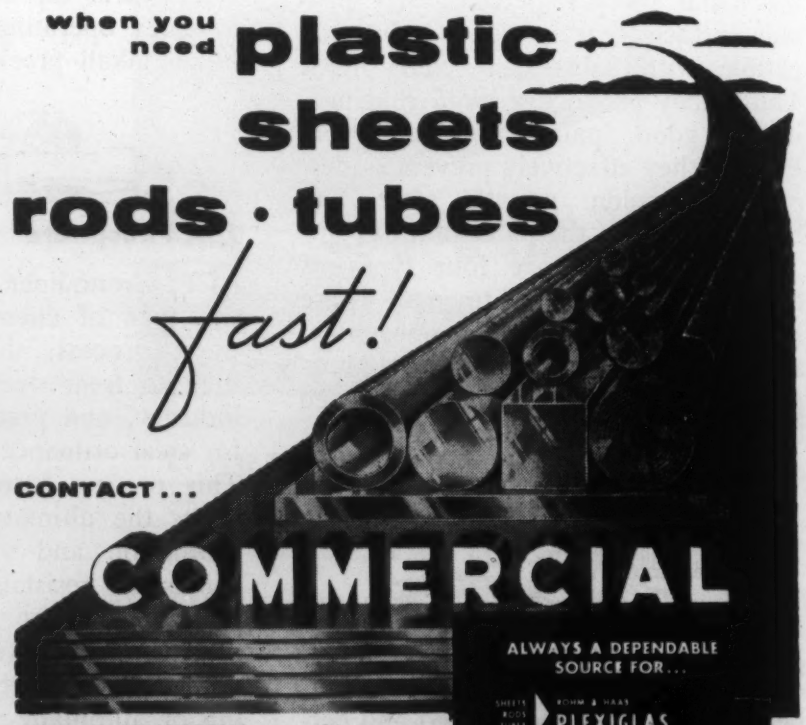

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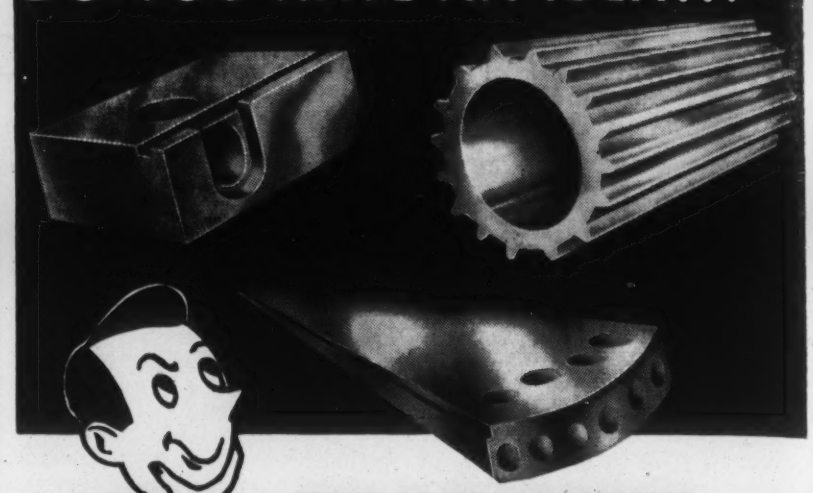

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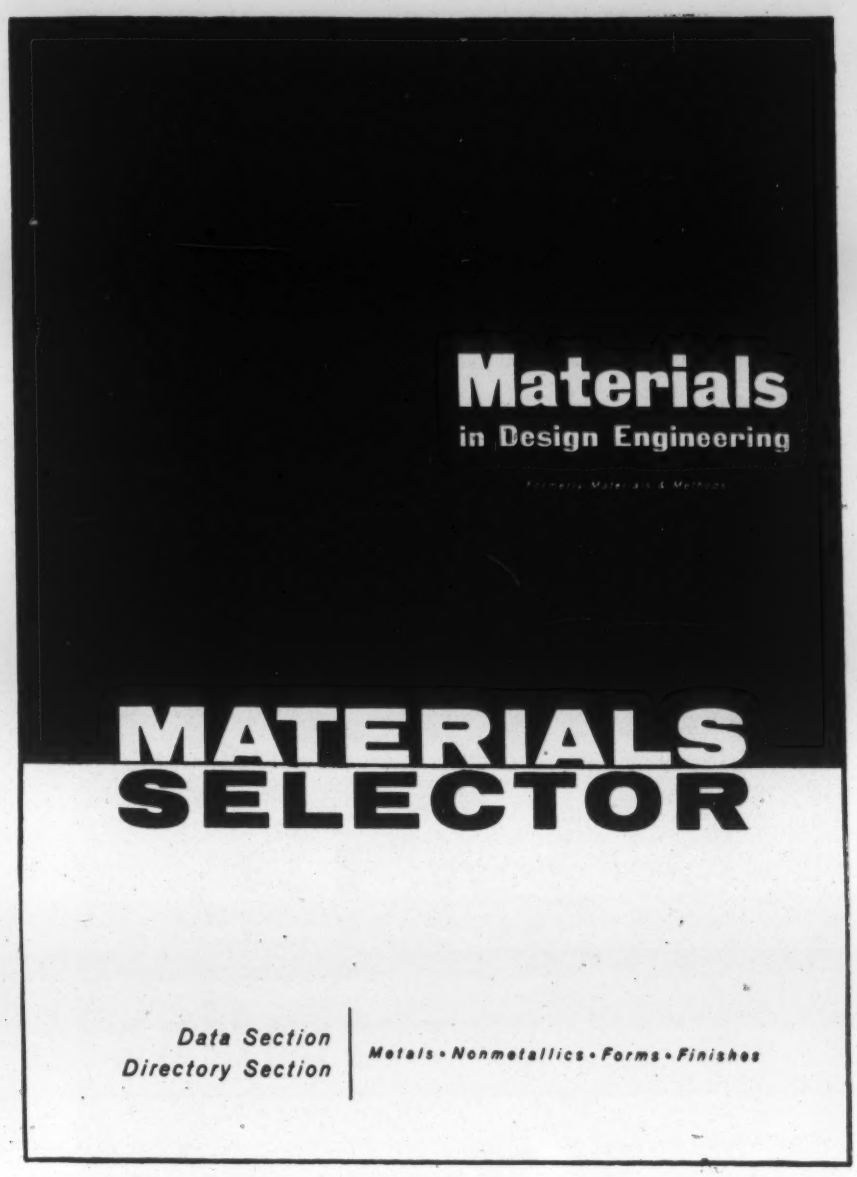

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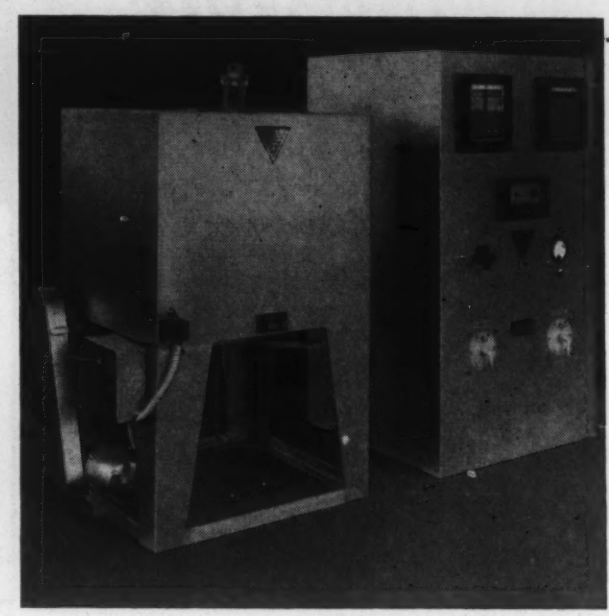

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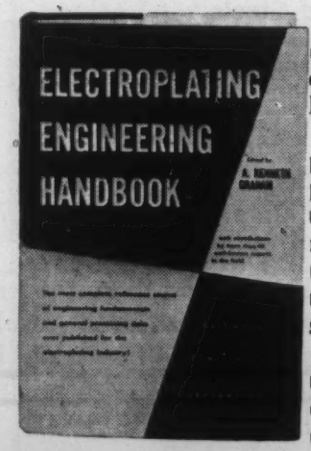

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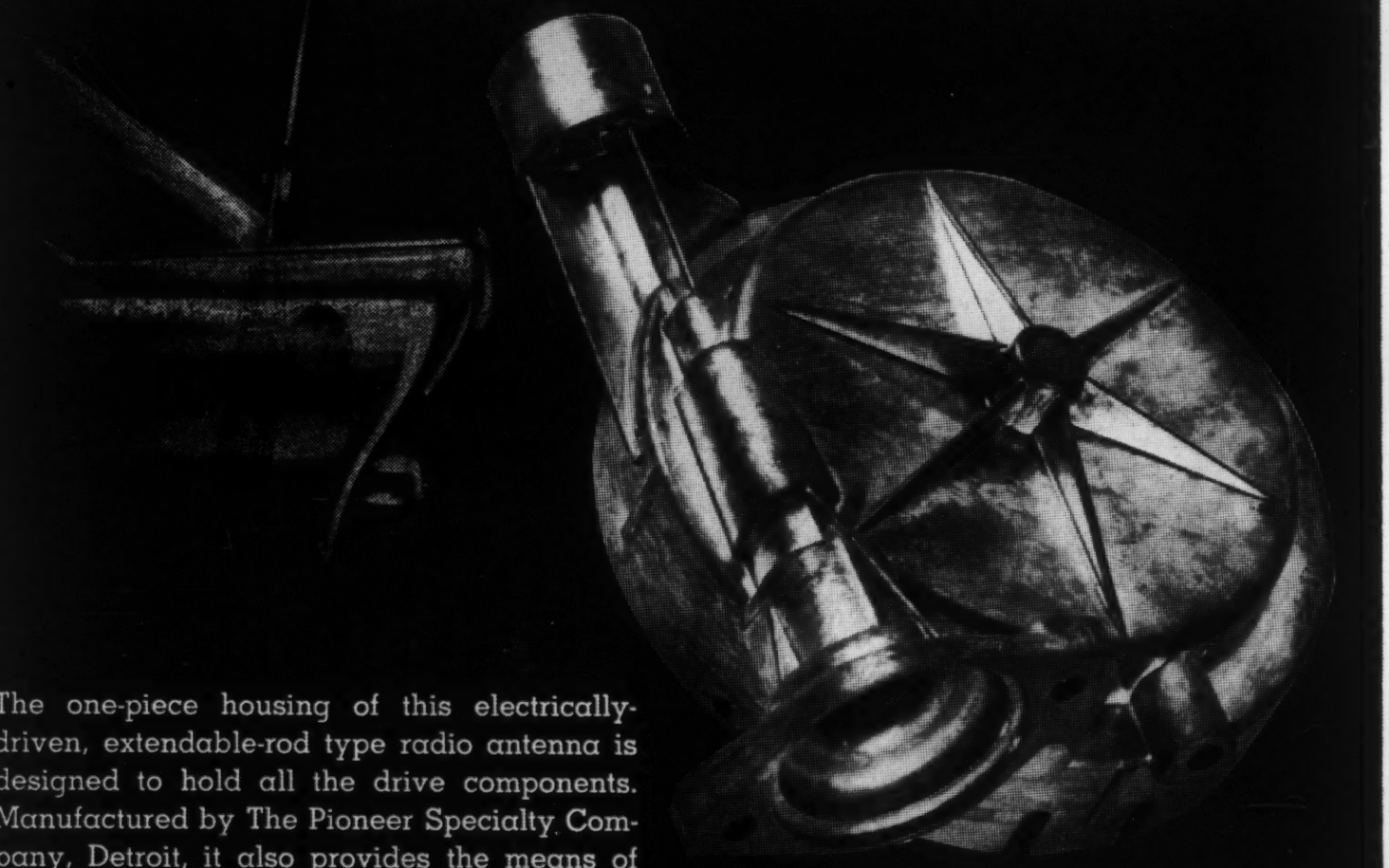

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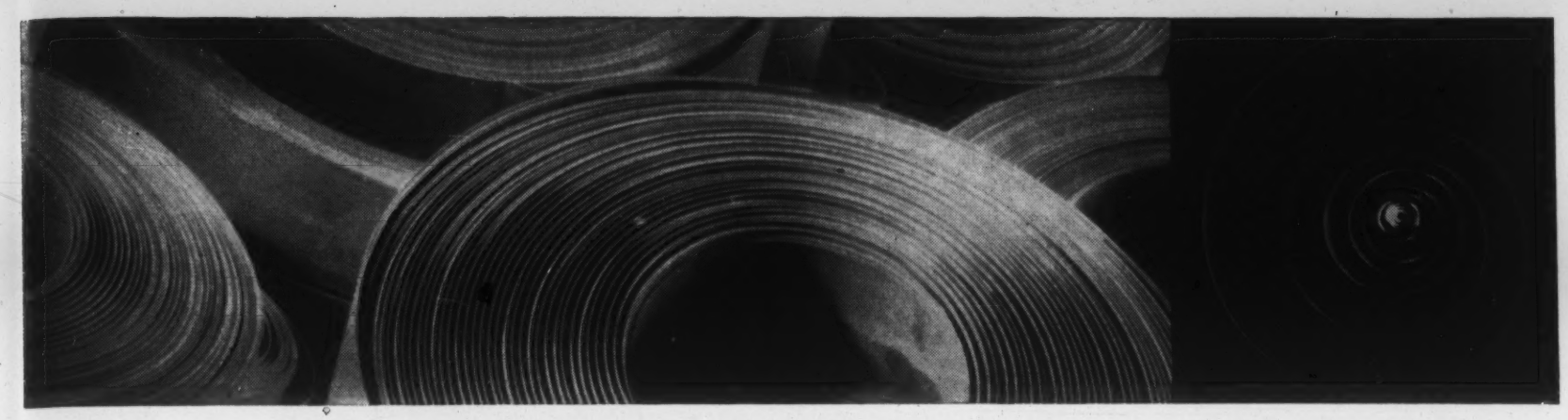

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.010 – .014″	“ “	3/16	to 5″	.050 – .060″	“ “	½	to 4″
.015 – .019″	“ “	3/16	to 7″	.061 – .064″	“ “	½	to 3″
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Cutaway section of Douglas Aircraft acoustic window used on the DC-7 below. The noise barrier is an acrylic pane (A) mounted in a foam rubber damper (B). Damper is retained in a metal pan (C). A flexible HYPALON seal (D) is compressed between the inner pane and the double thickness outer window (E). A neoprene seal (F) is cemented to the metal retainer.

Douglas Aircraft seals new acoustic window with Du Pont neoprene and HYPALON®

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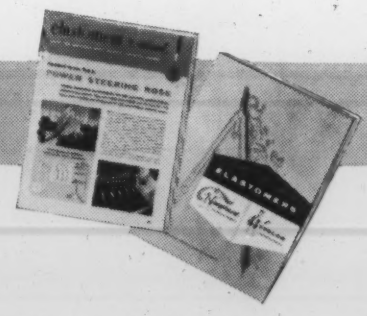

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